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May 8, 1987
GR: 87-75

PACKARD
A Canberra Company

Patricia J. Whiston
U.S. Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, IL 60137

RE: Control Number 77998

Dear Ms. Whiston:

Enclosed is the supplementary information which you requested in order to continue the review of our application dated December 20, 1984, for renewal of NRC License No. 12-04933-02. We hope that this will be sufficent to enable you to complete the evaluation. If clarification of this material is required, please contact this office.

Very truly yours,

Georgia L. Russell

Georgia L. Russell
Reguatory Affairs Assoc.

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SUPPLEMENTARY INFORMATION TO RENEWAL OF NRC LICENSE
NO. 12-04933-02

ORIGINAL APPLICATION DATED DECEMBER 20, 1984

1. **Radiation Safety Committee**

This point was addressed in our March 11, 1987 submittal. Although there is no basis for your concern regarding the continuity of the radiation safety program at Packard, we have, at your suggestion, established a Radiation Safety Committee. This committee will be composed of the Radiation Safety Officer, a senior technical employee experienced with the use of radioisotopes at Packard, a management representative and the Regulatory Affairs Officer. This committee will meet at least annually to review the safe uses of radioactive materials at Packard and to assure compliance with all regulatory requirements.

2. **Intended Use of Materials**

a) Research and development activities include the use of several radionuclides pursuant to development of instruments for radiation detection and measurement. In addition, our work on specific applications for individual customers requires a broad license with regard to types of isotopes. We have not used americium-241 or polonium-210 in any form for laboratory purposes for several years and have no foreseeable plans to do so. Any proposed use of such materials will be carefully reviewed by the RSO prior to implementaton. Typical research and development activities include biological radiotracer applications for metabolism studies, labeling for distribution and movement, biomedical, clinical and enviromental purposes. Typical quantities used per experiment or preparation are 0.5-10 microcuries. Significant radioloigcal hazards are absent during these experiments since the procedures do not normally produce aerosols, airborne particulates, radioactive fumes or high external dose rates. Shielded material containers, dedicated fume hoods, beta shields, isolated work areas, remote handling devices and continuous monitoring are devices and procedures available to Packard users should the need arise. Employees who participate in these activities are properly monitored by appropriate body and extremity dosimeters.

b) (1) The only device containing byproduct material which may be distributed to specifically licensed individuals is the Model 902 Electron Capture Detector associated with gas chromatographs.

(2) The maximum activity of the nikcel-63 foil is 10 millicuries.

(3) The magenta and gold colored label is an integral part of the detector, embossed directly on the metal. A drawing (Appendix A) and sample are enclosed. The date and serial number are inscribed before shipment.

(4) During the final test phase for these units, Packard verifies acceptance of the detector through the performance evaluation test (Appendix B), whereby a determination is made to confirm the proper operation of the nickel-63 source. Since the ECD is manufactured in Delft, Holland, and sent to Packard as a sealed unit for installation, quality assurance of the assembly is performed in Holland. Appropriate documentation is submitted with the product.

(5) Before transferring the byproduct material to a specific licensee, we require a current copy of his license authorizing his right to receive the type, form and quantity of material, which is kept on file in the Regulatory Affairs office.

c) The only byproduct material which Packard demonstrates at temporary job sites is barium-133, 20 microcuries, contained in liquid scintillation spectrometers. These demonstrations are hosted by general licensees, always in the physical presence of an authorized Packard user and under the provisions of our own specific license.

3. **Training**

We have an active training program relating to radioactive material usage at Packard , both for in-house and field personnel. We retain a record of this training for each employee, which contains dates of training, topics covered and certification by the individual.

4. **Leak Test Kits**

The requested instructions for using the Wipe-Test Kit PN700348 for the Electron Capture Detector are attached (Appendix C).

5. **Surveys**

a) Surveys of areas where radioactive material is used are accomplished weekly, regardless of nuclide or amount used, according to directive in our RAM Management Plan. These surveys take the form of both instrument surveys using a calibrated G-Monitor and wipe tests of predetermined locations. In addition, surveys and wipe-tests are done as frequently as necessary to monitor high-use areas and work locations outside of predetermined sites.

b) Surveys of storage areas for radioactive materials are also accomplished at weekly intervals of predetermined locations. Surveys and wipe-tests in (a) and (b) are carried out together.

c) The surveys are performed by a trained and qualified laboratory technician, under the direct supervision of an authorized user. The RSO will perform independent surveys of the same areas and in the same manner as the routine tests on a quarterly basis.

6. **Phosphorus-32 Procedures**

The scheduled use of phosphorus-32 at Packard has been modified since the original submittal. We have no plans to use phosphorus-32 in millicurie quantities during the lifetime of this license. Consequently, we are not submitting any special safety procedures relating to such use at this time.

7. **Waste**

Specific instructions for disposal of radioactive waste are contained in our RAM Management Plan. The pertinent section has been attached for your inspection (Appendix D).

8. **Personnel Monitoring**

We do not plan to use millicurie amounts of either hydrogen-3 or iodine-131 during the period covered by this license. If such quantities are used, the bioassay program will be consistent with the applicable regulatory guide (e.g. 8.9. Acceptabale Concepts, Models, Equations and Assumptions for a Bioassay Program).

9. **Laboratory Rules**

General Instructions in the safe use of radionuclides for laboratory personnel are contained in the RAM Management Plan. Employees are instructed in these procedures as a part of our training program. The appropriate sections are enclosed (Appendix E).

10. **ALARA**

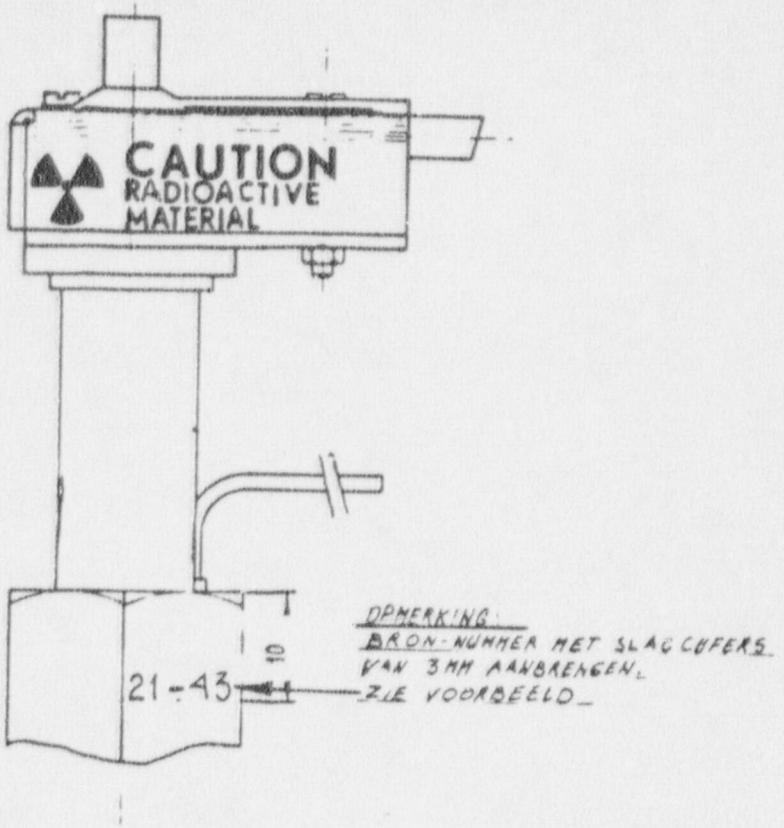
A review of Packard dosimetry records confirms that most personnel working with radioactive materials do not have detectable radiation exposures. For those few who are exposed, the maximum annual whole body (or extremity) dose equivalent is less than 10% of the applicable limits. To the best of our knowledge, there has never been a detectable intake (via ingestion or inhalation) of radioactive material at Packard. Based on this information we are confident that you would conclude that exposures are currently ALARA, and that further expenditures of resources to establish a formal ALARA program are not justified.

11. **Current Program**

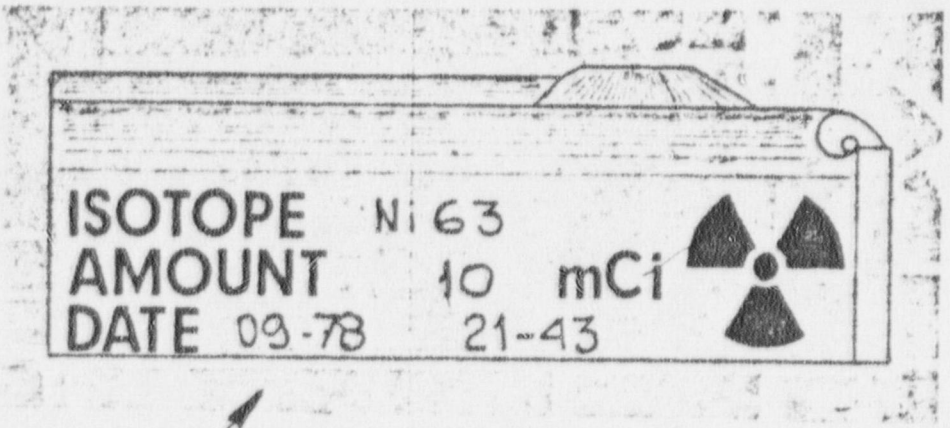
The information contained in the license ammendment issued July 15, 1986, is current and unchanged.

APPENDIX A

7929114



VIEW ON ARROW



ALGEMENE RUWHEID	SCHAAL 2:1	MATERIAAL	SAMENSTELLINGS NR AAI 5L
TOLERANTIES (TENZIJ ANDERS VERMELD) MAAT HOEK		NABEWERKING	MODEL NR
			ORDER NR
E.C.D. ASSY WITH RADIATION SOURCE		APP CODE 427	D NR D_29114
NAAM BRDIAPER	VERVANGT		20-7-80
CONTR	DATUM 15-2-76	PACKARD-BECKER BV	FORM

7.2.7 PERFORMANCE EVALUATION TEST

The performance evaluation test has to be carried out only after installation of the GC or in case of doubt about the correct functioning of the instrument. A verification of the entire system can be achieved.

Before actually performing the test by injecting a test sample, the following must be checked:

- Select a recorder speed of 10 mm/min.
- Verify that gass settings are correct (section 7.2.6).

During final tests in our factory, the following method was brought into memory for performing this test:

- Code 333.333 for isothermal analysis.

By selecting this method all parameters are set to their correct values.

Press: <PAGE #> <5> <ENTER>
<LINE #> <2> <ENTER>
<method number> <ENTER>

The factory programmed method is preset for channel A; for channel B you will have to change one of it's parameters.

Press: <PAGE #> <2> <ENTER>
<LINE #> <1> <ENTER>
<2> <ENTER>

Press: <STATUS>

and wait until the text 'READY' is displayed for program status.

INJECTION

Inject 1 µl of test sample 3 into the appropriate injection port and press the START/RESET switch located beside the injection ports. A chromatogram which closely resembles the test chromatogram in figure 7.2.3 should be observed.

After elution of the aldrin peak the analyzing process can be stopped by pressing the START/RESET switch again. Pressing this key another time will reset your GC-time clock to zero again.

Test sample 3 contains 10^{-7} g/ml aldrin, dissolved in n-heptane.
(P.B. part number 27.00.600)

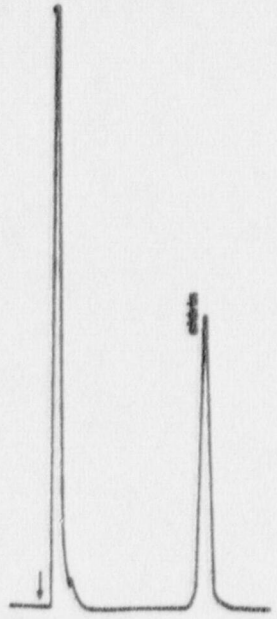


Figure 7.2.3 *ECD test chromatogram*

TEST METHOD PARAMETERS

The method used for analyzing test sample 3 is identified by its code 333.333. This method is factory programmed into GC memory upon receipt of the instrument.

The parameter values for test sample 3 are:

FROM PAGE 1 (GC-control program)

oven limit °C	: 250	oven rise °C/min	: 0
detector temp. °C	: 220	time initial min	: 99
injector temp. °C	: 220	time final min	: 0
auxiliary temp. °C	: 0	stabilization time	: 1
oven initial temp. °C	: 180	cycles	: 1
oven final temp .°C	: 180	Tx-mode	: 1
		sampler mode	: 0

FROM PAGE 2 (Detector signal control)

independent	: 2	range B	: 2
attenuator A 2	: 8	attenuator B 2	: 8
recorder offset A%	: 10	recorder offset B%	: 10
recorder polarity	: 0	recorder polarity	: 0

FROM PAGE 3 (Tx-program)

Tx-time	Function	Data
0.01	zero A	10
0.01	zero B	10

APPENDIX C

Directions for Use of Leak Test Kit for Electron Capture Detectors used in Gas Chromatograph Ovens, and Incorporating Nickel-63 Foil

Materials in Leak Test Kit:

Three (3) sample tubes, labeled "A", "B", "C", each with a cotton swab inside.
One (1) reagent vial of EDTA Solution.
One (1) preprinted mailing label for return of samples to Packard.
One (1) "Sample Identification": form to be completed and returned with the leak test samples.
One (1) Directions for use of leak test kit.

Directions:

Oven Interior Wipe

1. Take the swab from tube "A" and dip the swab in the EDTA solution vial to wet the swab. Remove excess EDTA by pressing the swab in the neck of the vial.

2. With the wet swab, wipe a $100cm^2$ area (about 4" x 4") of the oven interior (any location in the oven or inside lid). Rotate the swab while wiping.

3. After the wipe has been completed, reinsert the swab into tube "A" (cotton tip up). Allow the swab to dry overnight.

Detector Exterior Wipe

1. Take the swab from tube "B" and dip the swab in the EDTA solution reagent vial to wet the swab. Remove excess EDTA as above.

2. With the wet swab, wipe the exterior surface(s) of the detector, immediately adjacent to the detector (top or chimney) output(s) which is in the block containing the signal cables. Rotate the swab while wiping.

3. After the wipe has been completed, insert the swab into tube "B" as above and allow to dry overnight.

Background Control

1. Take the swab from tube "C" and dip the swab in the EDTA solution vial to wet the swab. Remove excess EDTA as above.

2. Insert the wetted swab into tube "C" as above and allow to dry overnight. (This control swab will therefore have the same drying time and handling as the wipe test samples.)

continued...

Return Completed kit to Packard

1. After the sample tubes have dried overnight, cap each of the three tubes. Make certain the "Sample Identification" form has been completed.

2. Return the sample tubes with the completed "Sample Identification" form to Packard Instrument Co., using the preprinted label with the kit.

8) Dispose of radioactive materials which are no longer useful in an approved fashion (see Section 4). Be prepared to assist the Regulatory Affairs Manager in periodic disposal activities when requested.

9) Transmit during the first week of each month a current inventory to the Regulatory Affairs Office which will contain the following minimum information a) control number(s) b) description c) radionuclide d) total activity in uCi e) reference date. If there has been no change from the previous month, a note to that effect will suffice.

10) Carry out a semi-annual physical inventory of radioactive materials during the first week of December and June.

b. In order to maintain a current daily inventory of ALL radioactive materials wihin the plant, it is necessary that the Regulatory Affairs Manager be informed of all shipments of such materials. This shall be accomplished by the transmittal of daily traffic reports by the Managers of Instrument Production and Technical Services.

c. The Regulatory Affairs Manager will maintain and periodically update a master inventory of RAM activity in all departments. The Regulatory Affairs Manager will coordinate a physical inventory on a semi-annual basis of all RAM.

4. Disposal/Shipments

a. The shipment of radioactive material from Packard to a customer is governed by the Hazardous Materials Shipping Guide, Form MSF #02, which should be consulted for the correct procedure. The Regulatory Affairs Manager will assist in questions which arise regarding transportation regulations.

b. Waste Disposal

Whenever possible, a policy of radioactive waste minimization and volume reduction shall be observed. The use of drain disposable scintillation solvents is encouraged. Dispose of these permitted solutions containing $\leq$0.05 uCi/ml of H-3 or C-14 into the sanitary sewer with a 10:1 excess of water. Store isotopes with half-lives of 60 days or less for decay over 10 half-lives, after which RAD labels are to be removed and source disposed of in ordinary trash.

On a monthly basis or more frequently, departmental Custodians shall consolidate accumulated RAM waste in common holding areas. These shall be the waste storage cabinets for sealed liquids, the lead safe for solid rod or pellet sources, the solid waste drum for other solid waste (all in the loading dock area), and the Lab. B controlled temperature area for unsealed liquids.

Obtain a key from Regulatory Affairs. Regulatory Affairs shall be notified when waste is brought to these areas by an appropriate entry on the current RAM waste inventory sheet (Appendix C) affixed to the cabinet or drum. All RAM shall be accompanied by a tally of total activity in uCi for each isotope, and date of assay for isotopes with short half-lives. When sufficient waste has accumulated, the Regulatory Affairs Manager and a Custodian will prepare waste as follows for contract disposal:

1) Solid Waste - Uncompacted/No External
Standard Pellets, Rods or Foils

Solid, uncompacted waste may be packaged in a variety of containers, such as steel or fiber drums, cardboard boxes or wooden crates, provided the waste is 1) compactible and 2) uniformly distributed throughout the container. This type of waste must also be free of liquids and must not contain any animal carcasses. It must also be free of loose syringe needles or needles of any other type.

To pack this waste:

a) Open and carefully inspect empty container for holes, cracks, or weak spots.

b) Place one 4 mil. plastic bag inside empty container. Drape top portion of bag over top edge of container to prevent contaminating the outside.

c) Add waste until the drum is full. Try to minimize waste volume by expelling excess air from plastic bags, using appropriate sized boxes, etc.. Seal the bag with a twist tie. Replace the lid and tighten down the ring.

d) Anyone who deposits waste into this drum must log the activity of each isotope on the attached sheet. (See Appendix C).

e) Assign a number to the drum and place the same number on the inventory sheet, a copy of which is given to Regulatory Affairs. Label the drum with "radioactive" tape.

f) Monitor the exterior of the drum with a G-M type survey meter and record the average dose rate on the drum label.

g) Contact Regulatory Affairs to arrange removal of drum to the Radiation Storage Shed. Set up a replacement drum with plastic liner, labels and log sheet.

2) Solid Waste - External Standard Pellets, Rods and Foils

a) External Standard Pellets - Radium-226 and Americium-241 - load pellets into pigs in amounts of one millicurie or less. Label the pig with isotope and activity written on "radioactive material" label or tape. Load pigs into a plastic bag-lined 5 gallon pail, secure with twist-tie and replace lid.

b) External Standard Rods - Cesium-137 and Ba-133 - place rods into a plastic bag-lined 5 gallon pail, secure with twist-tie and replace lid.

c) Foil Sources - Tritium and Nickel-63 - place foils into a plastic bag-lined 5 gallon pail, secure with twist-tie and replace lid.

The limit is 70 mCi per pail, but the average dose rate at the pail surface should not exceed 200 mrem/hr. If hot spots exist on the pail, the disposal company should be so notified. Pail should be monitored after packing and the average dose rate recorded on label for the information of the hauler. Complete an inventory sheet for each pail, with a copy to Regulatory Affairs.

3) Scintillation Vials - Radioactive

Scintillation vials are only vials having a capacity of 20 ml. or less that have been used in scintillation work. Only the following isotopes may be disposed of as radioactive scintillation vial isotopes:

I	125	P	33
Cr	51	I	131
Fe	59	Se	75
S	35	Ge	68
P	32	Cd	109
Ca	45	Ce	141
Na	22	Sc	46
H	3	Cu	64
C	14	Au	195
Co	57	Tc	99
Rb	86	Gd	153
Ga	67	Sn	119
Zn	65	Sn	113
In	111	Hg	203
Cl	36		

Other metals in scintillation fluid such as Ni-63, Ti-204, Fe-55, Cs-137, etc. may not be disposed of in this way. These liquids must be solidified and disposed of in a solid waste drum.

Scintillation vial drums are to contain ONLY vermiculite and scintillation vials containing small amounts of scintillation fluids. Boxes, trays, separators or other types of waste are not allowed in scintillation vial drums.

To pack this type of waste:

a) Open and carefully inspect a steel drum for cracks, holes or weak spots.

b) Place one 4 mil. plastic bag in drum. Drape top portion of bag over top edge of drum to prevent contamination of drum.

c) Place about 4" of vermiculite in bottom of drum. NOTE: ONLY vermiculite #3 or #4 grade may be used at this time.

d) Add scintillation vials and vermiculite in layers until drum is full, ending with vermiculite.

e) Close plastic liner bag and seal with twist tie.

f) Close drum by replacing lid and tightening ring.

g) Complete an inventory sheet for the drum (see Appendix C). The drum shall be marked with a number asssigned by Regulatory Affairs, and the same number placed on the inventory sheet for that drum. This information will be given to Regulatory Affairs, as well as being maintained with the drum.

h) Full drums will be stored in the Radioactive Waste Storage Shed until pickup can be arranged by Regulatory Affairs.

i) Whenever working with these radioactive liquids, a NIOSH approved respirator for radioactive materials and organic solvents shall be worn by all personnel in the area. Means of entry to the area shall be restricted to authorized personnel.

j) Personnel shall also wear protective outer clothing and gloves impervious to chemicals due to potential splashing of solvents, etc.

k) Wipe tests shall be conducted in the area where the filling operation occurred in order to verify that there is no residual radioactive contamination.

4) Scintillation Vials - Deregulated

Deregulated scintillation vials must meet the following criteria to be classed as such:

a) They must have been used only for scintillation work.

b) They must contain only C-14 and/or H-3 at a rate of .05 microcuries per gram (ml) or less, with no more than 1.5 mci combined of H-3 and C-14 per 55 gallon drum.

To pack this type of waste:

a) Open and carefully inspect drum for cracks, holes or weak spots.

b) Place one 4 mil. plastic bag in drum. Drape top portion of bag over top edge of drum to prevent contamination of drum.

c) Place about 4" of vermiculite in bottom of drum. NOTE: ONLY vermiculite #3 or #4 grade may be used at this time.

d) Add scintillation vials and vermiculite in layers until drum is full, ending with vermiculite.

e) Close plastic liner bag and seal with twist tie.

f) Close drum by replacing lid and tightening ring.

g) Proceed as in 3. g-k.

5) Other Radioactive Vials/Aqueous Vials

All vials not used in scintillation vial work are classed as "Other Radioactive Vials". These may not exceed 50 milliliters capacity and must contain aqueous solutions.

To pack this type of waste:

a) Open and carefully inspect a steel drum for cracks, holes or weak spots.

b) Place one 4 mil. plastic bag in drum. Drape top portion of bag over top edge of drum to prevent contamination of drum.

c) Place about 4" of vermiculite in bottom of drum. NOTE: ONLY vermiculite #3 or #4 grade may be used at this time.

d) Add vials and vermiculite in layers until drum is full, ending with vermiculite.

e) Close plastic liner bag and seal with twist-tie.

f) Close drum by replacing lid and tightening ring.

g) Proceed as in 3. g-k.

6) Absorbed Liquids - Aqueous

Any aqueous liquid in a container larger than 50 milliliters must be packaged in a drum set up for disposal of liquids not contained in vials. Scintillation or organic fluids must now be packed in either "bulk" form or be contained in vials and packaged accordingly.

To pack absorbed aqueous liquids:

a) Open and carefully inspect a steel drum for cracks, holes, or weak spots.

b) Place approximately 2" of vermiculite absorbent (#3 or #4 grade) inside drum before inserting plastic liner bag.

c) Insert one 4 mil. plastic liner bag and drape top edge of drum to prevent contamination of exterior of drum.

d) Begin adding liquid in ratio of approximately one part liquid to four parts vermiculite (Example: if 1 liter of liquid is added, approximately 4 liters (or 1 gallon) of vermiculite should be added to drum FIRST).

IMPORTANT!!!

- Do not mix liquids that may react with each other and result in a dangerous compound.

- A maximum of 15 gallons of liquid may be disposed of in a 55 gallon drum.

- Always add vermiculite before adding liquids.

e) Continue adding vermiculite and liquids until drum is full.

f) Close bag and seal with twist-tie.

g) Label bag "RADIOACTIVE".

h) Close drum by replacing lid and tightening ring.

i) Proceed as in 3. g-k.

7) Bulk Scintillation Liquids

Scintillation fluids, either the commercially prepared solutions or the scintillation "cocktail" liquids mixed at this facility, may be disposed of as a "bulk" liquid after being poured into double-walled bulk liquid containers. This consists of a 16 gallon tighthead steel drum inside of a 55 gallon openhead steel drum. This method of disposal is more economical than disposing of scintillation fluids as absorbed liquids.

To pack bulk scintillation fluids:

a) Open double-walled drum (outer drum).

b) Remove 2" bung from inner drum and set bung aside.

c) Inspect drums for cracks, holes or weak spots. Fill space between outer and inner drums with vermiculite.

d) Add liquids ONLY to the inner drum. Do not discard vials, bottles, syringes, etc. in bulk scintillation fluid drums. ONLY liquids are to be put in these drums.

e) Continue adding liquid until inner drum is full.

f) Reinstall bung cap to inner drum.

g) Label inner drum "RADIOACTIVE".

h) Close outer drum by replacing lid and tightening ring.

i) See page ten for list of acceptable isotopes.
j) Proceed as in 3. g-k.

8) Temporary Radioactive Waste Receptacles (Small Kitchen-Type Trash Cans) - Solid Waste Only

a) These containers are used for disposal of paper, gloves, etc. on which minute contamination may have occurred. They should be located in areas where low level radioactive waste is generated. They are to be lined with a yellow plastic "radioactive"bag.

b) If broken vials are to be placed in the receptacles, they are first to be placed in a plastic bag which will be sealed and a radioactive label placed on the bag listing the total possible activity present per radionuclide.

c) These containers will be emptied weekly by the responsible area users and placed in the solid waste drum, with inventory sheet properly completed.

9) Radioactive Waste Storage Shed

All radioactive sources stored in the Radioactive Waste Storage Shed shall have prior approval of Regulatory Affairs before being placed there. This includes drums, etc. for which disposal inventory sheets must be completed prior to placement. Maintenance personnel shall conduct weekly checks of the storage shed as to condition of drums and inventories present on all drums; a radiation survey along the outside surface of the shed shall be conducted to determine the radiation levels. The radiation levels on the external surface of the shed shall not exceed 2 mR/hr. Any irregularities noted shall be reported to Regulatory Affairs. The Regulatory Affairs Manager shall contact an appropriate waste broker for disposal on a regular basis.

F. SAFETY AND HANDLING PROCEDURES

1. Routine Procedures

All users of radioactive material at Packard shall follow these procedures.

a. Wear protective clothing as necessary when handling radioactive material, according to the following guidelines:

1) assembly of external standard sources into instruments - gloves

2) assembly of radium pellets - gloves and lab coat

3) manufacture of liquid sources - gloves, lab coat and safety glasses

4) bulk transfers of liquids - gloves, lab coat, and splashproof goggles.

b. Wear disposable gloves at all times when handling materials.

c) These containers will be emptied weekly by the responsible area users and placed in the solid waste drum, with inventory sheet properly completed.

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4) bulk transfers of liquids - gloves, lab coat, and splashproof goggles.

b. Wear disposable gloves at all times when handling materials.

c. Wear radiation dosimetry devices. The film badge normally is attached either to one's collar, pocket or at waist level. The ring badge shall be worn on a finger that would be nearest the source with the name label facing the source. Dosimetry devices shall be stored in areas away from radiation sources.

d. Monitor hands and clothing for contamination if necessary and appropriate, after working with radioactive material. Always wash after working with liquids.

e. Eating, drinking or smoking is prohibited in the immediate area where radioactive material is handled. Storage of food with radioactive material is prohibited.

f. Dispose of radioactive waste only in specially designated receptacles. Liquid waste which is soluble or dispersible in water may be disposed of in a sewer system and shall be within regulatory limits (0.05 uCi/ml for C-14 and H-3, 10 CFR Part 20.303). These must be disposed of in designated sink drains and shall be so noted on the inventory sheet. Check with the RSO prior to disposal of greater activities of H-3 or C-14, or other radionuclides of any activity via the sewer system.

g. Glassware slightly contaminated and capable of being reused shall be placed in a glass beaker and labeled "Contaminated-Radioactive" with the identification of radionuclide and approximate activity until decontamination is carried out.

Glassware dedicated for reuse with a particular radionuclide shall be labeled "Caution-Dedicated for "XXX" radionuclide" where "XXX" specifies the radionuclide. Place contaminated glassware for disposal into a yellow plastic bag properly labeled with isotope(s) and respective total activity, and place in the solid radioactive waste drum with an appropriate entry on the inventory sheet.

It is advisable to use disposable labware whenever possible.

h. Never pipette by mouth--use mechanical devices.

i. Survey working areas for contamination when necessary and appropriate after utilizing radioactive material. If using C-14, I-125 and I-129, see Regulatory Affairs for a special survey meter calibrated for these radionuclides. Radiation surveys and wipes shall be conducted weekly following CTP 436 of all areas where radioactive materials are used, stored or disposed.

j. Confine all radioactive solutions in process in tightly covered containers plainly identified and labeled with compound name, radionuclide, date, activity in either DPM or microcuries and name of user. The same identification is needed for solid sources being processed, with the exception of external standards destined for instrument production.

k. High level radiation sources i.e. external standard pellets shall be transported in shielded containers within the building. Never transport RAM outside the building before checking with Regulatory Affairs.

l. Radioactive material shall be stored in properly labeled storage areas when not in immediate use.

m. Work area(s) shall have the benchtops covered with absorbent paper with plastic backing. Liquid radionuclides shall be worked with in plastic or stainless steel trays whenever feasible in order to confine liquids if spilled. The working areas shall be delineated from other areas through means of a tape marked "radioactive".

n. Confine work with volatile radionuclides to lab hoods that are properly operating according to NIOSH specifications. Check the hood fan's exhaust capabilities with tissue paper, etc. prior to working with RAM.

o. Store all high level sources such as Ra-226 and Am-241 pellets in shielded labelled containers when not being utilized.

p. In the event of a spill of any quantity or activity, notify the RSO or designee. Any apill is considered an emergency; refer to F(2): Emergency Procedures.

2. Emergency Procedures

a. Any spill is considered an emergency. Notify the RSO or designee whenever a spill occurs. Evacuate the immediate area, but do not allow workers to leave the general area until they have been surveyed to determine that they have not been contaminated. The individual who caused the spill shall be responsible for notification. Only trained and approved individuals designated by the RSO shall work with radioactive material, including cleanup. The RSO may be notified in the event of any emergency at the discretion of the Regulatory Affairs Manager.

b. Cover the spill with absorbent paper to prevent spreading.

c. Clean up following procedure in F.3.b.

d. Survey the spill area, hands and clothing for contamination with a pancake-type probe (in Regulatory Affairs office) or thin end window G-M survey meter (on most sensitive scale). If the spill involves C-14 or H-3, Regulatory Affairs shall direct appropriate wipe tests.

e. Prepare a short report to the Radiation Safety Officer (Appendix F). Documentation shall include, but not be limited to the following: compound, radionuclide and activity, volume of spill, individual(s) involved in the accident and cleanup, time, date and location of the spill, cause of the spill, and how one can prevent a reoccurrence, clean-up information, and notification information.

f. Bioassay samples may be collected and submitted to a commercial laboratory if it is suspected that a worker has ingested or inhaled contamination. Treat all spills with similar caution, regardless of volume or activity.

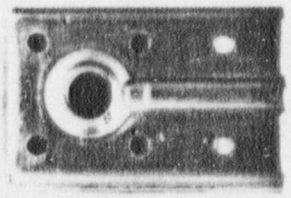
g. The RSO or designee shall activate the Emergency Response Team for 1)any spill which is greater than 500ml(~2cups) of any activity 2) a spill of any quantity which involves more than 100 uCi total activity.

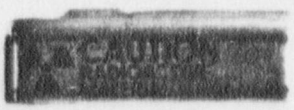
3. Decontamination Procedures

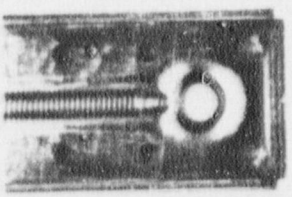
The following describes decontamination procedures for personnel and equipment. This material should be known to all personnel who come into contact with radioactive materials as part of their daily job. All decontamination procedures shall be performed under the direction of the RSO or designee.

a. Decontamination Kit

The following items constitute the minimum necessary for an acceptable kit to meet the normal possible incident/accident (I/A) that might occur at Packard.




CAUTION



UNITED TECHNOLOGIES PACKARD

2200 Warrenville Road
Downers Grove, Illinois 60515
(312) 969-6000
Telex: 21-0031
Facsimile (312) 969-6511

Packard Instrument Company

25 February 1986

Dr. William J. Adam
U.S. Nuclear Regulatory Commission
Materials Licensing Section
799 Roosevelt Road
Glen Ellyn, Illinois 60137

RE: Control Number 80385

Dear Dr. Adam:

In reply to your letter of 18 February 1986, we have enclosed the requested information. We hope this information will allow you to expeditiously continue the peruse of our amendment.

As you already know, it is very important that we at least receive acceptance from you concerning the release of the Centre Circle building.

If you have any questions or need further information, please feel free to contact this office.

Very truly yours,

John M. Simonin

John M. Simonin
Regulatory Affairs Manager

rc
Encl.

cc: G. H. Kremer
Stan Huber Consultants
P. Special

John Martin Simonin
Regulatory Affairs Manager

Packard Instrument Company
2200 Warrenville Rd.
Downers Grove, IL. 60515
(312) 969-6000 Extension 322

Formal training in Radiation Safety:

1974.....Four week D.O.L. OSHA course for industrial hygienist covering radiological health and safety procedures at the OSHA Training Institute, Des Plaines, IL.

1976.....Two week NRC course on licensing held in Silver Springs, Maryland.

1977.....One week NRC course on industrial radiography at LSU in Baton Rouge, LA.

1978.....Two week NRC course on radiological emergency response at Las Vegas and Mercury Test Site in Nevada.

1983.....One week course on transportation and handling of radioactive material taught by Don Edling from Monsanto-Mounds facility.

1984.....D.O.E. one week course on transportation of radioactive materials and emergency response to radiological incidents in Des Plaines, IL.

1985.....U.S. Ecology course on transportation and handling of radioactive wastes.

Experience working with radioactive materials:

1975-1985 — State of Illinois-varied experience in working with various radionuclides such as, radium through training of personnel and conducting radiological inspections of spent fuel shipments. Supervised 15 field personnel. Responsible for the development of the sensitive radiation detection instruments used by the Illinois State Police.

1985 to Present — Packard Instrument Co. - Regulatory Affairs Manager handling NRC, IDNS, EPA, DOT, DOL, FDA, and FCC matters for the company. Initiated and implemented Packard's Centre Circle closure plan.

List of Radionuclides	Source Type	Maximum Amount (mCi)
Ra-226	Sealed	14.1
Ir-192	"	90,000.0
Co-60	"	5.0
Cs-137	"	50.0
Am-241	"	0.130
H-3	Unsealed	2.0
C-14	"	2.0
Ba-133	Sealed	0.02
I-129	"	0.001

Ray O'Day

Education

B.S. Biology, Rutgers University 1957
Field Medical Service School 1961
Clinical Laboratory School 1962
Tissue Culture and Tissue Bank School 1963
Handling and use of Radioactive Material,
Groningen, The Netherlands 1983
Principals of Radioactivity
USNRC Form 3 1984

Experience

Surgical Team, 2nd Battalion 6th Marines 1961
Instructor, Tissue Culture School,
Naval Medical Research Institute 1962-1967
Radiochamistry experience at Packard Instrument
Company, Handle 3H, 14C, 125I in Research Lab
1983-1985.

CARBON 14 UNSEALED 5.14 $\times 10^5$ DPM
TRITIUM UNSEALED 2.45 $\times 10^6$ DPM

Ray 2124

UNITED TECHNOLOGIES PACKARD

24 February 1986

TO: M. Simonin

FROM: J. Norris

RE: NRC License Amendment

Over the past 2½ years, I have worked with the following radioactive materials while employed at Packard Instrument Company:

Radionuclide	Isotope Form	Maximum Amount(mCi)
Carbon-14	Unsealed & sealed	.110
Tritium	Unsealed & sealed	.110
Radium-226	Sealed	.600
Iodine-129	Unsealed	.100
Cesium	Unsealed	.100
Barium	Sealed	.200

James R. Norris

J. Norris

rc

cc: P. Special

UNITED TECHNOLOGIES PACKARD

24 Feb 1986

TO: M. Simonin

FROM: K. Neumann

RE: NRC License Amendment

My experience with the following radioactive materials has taken place over the past 17 months while employed at Packard Instrument Company:

RADIONUCLIDE	FORM	MAX AMT (mCi)
H-3	Unsealed	20
C-14	"	10
P-32	"	1
Cl-36	"	2
I-125	"	5

Ken Neumann

FEB 18 1986

Packard Instrument Company, Inc.
ATTN: Gerhard H. Kramer, Ph.D.
Vice President and General
Manager
2200 Warrenville Road
Downers Grove, IL 60515

Gentlemen:

We have reviewed your letter dated December 16, 1985 requesting an amendment to NRC License Number 12-04933-02 and find that we will need additional information as follows:

It is not clear from your letter to what extent the individuals you wish to add as authorized users have had "hands-on" experience with radioisotopes. Please submit a summary of the hands-on experience with radioisotopes for Ms. D. Mrkvicka, and Messrs. K. Neumann, J. Norris, R. O'Day, and J. M. Simonin and include the types of isotopes involved as well as maximum amounts and forms (i.e. sealed or unsealed sources) utilized, the location and the dates during which this experience was gained.

We will continue our review of your application upon receipt of this information. Please reply in duplicate, within 30 days, and refer to Control Number 80385.

Sincerely,

Original Signed By
William J. Adam, Ph.D.
Materials Licensing Section

RIII
WJA
Adam/cm
2/18/86

Packard Instrument Co. 2200 Warrenville Road Downers Grove, IL 60515 Tel. 312-969-6000 TLX 21-0031 FAX 312-969-6511

PACKARD
A Canberra Company

26 June 1986
JJC 86-188

Ms. Evelyn R. Matson
Materials Licensing Section
U.S. NUCLEAR REGULATORY COMMISSION (Region III)
799 Roosevelt Road
Glen Ellyn, IL 60137

Reference Control Number: 81472

Dear Ms. Matson:

This letter is written in response to your inquiry regarding our request to amend our NRC license 12-04933-02. Please find our response:

1. Time devoted to accomplishing the RSO's duties and responsibilities;

   It is intended that Mr. Booth spend one or two days a month on site performing related RSO duties and responsibilities; however, Radiation Management Corporation (RMC) is prepared and able to provide all services required to meet the position responsibilities, should this be required. Please note that both Packard and RMC are wholly owned subsidiaries of the parent corporation (Canberra Industries, Inc.), and as such share mutual corporate and management controls and directions.

2. Response to emergencies (i.e., on site contact or time needed to respond);

   RMC has established and maintains a comprehensive emergency response capability for its Emergency Medical Assistance Program, of which the RMC office in Schaumburg, Illinois is an integral part. The company has a nationwide emergency notification system based in Philadelphia, PA and is able to access rapidly medical and radiological assistance for any emergency. Thus Packard will be able to obtain radiological or medical assistance from Mr. Booth or another qualified RMC as quickly as it could contact its own employee.

2pp.

3. Provisions for an alternate, qualified RSO when Mr. Booth is unavailable;

   Mr. David Groff, a professional health physicist with eight years experience in health physics, located at RMC in Schaumburg, IL office, is designated as alternate RSO. If required by circumstance, RMC has additional senior level personnel, including two certified health physicists, available for consultation and backup.

4. Provisions for an on site person and sufficient staff to support the Radiation Safety Program;

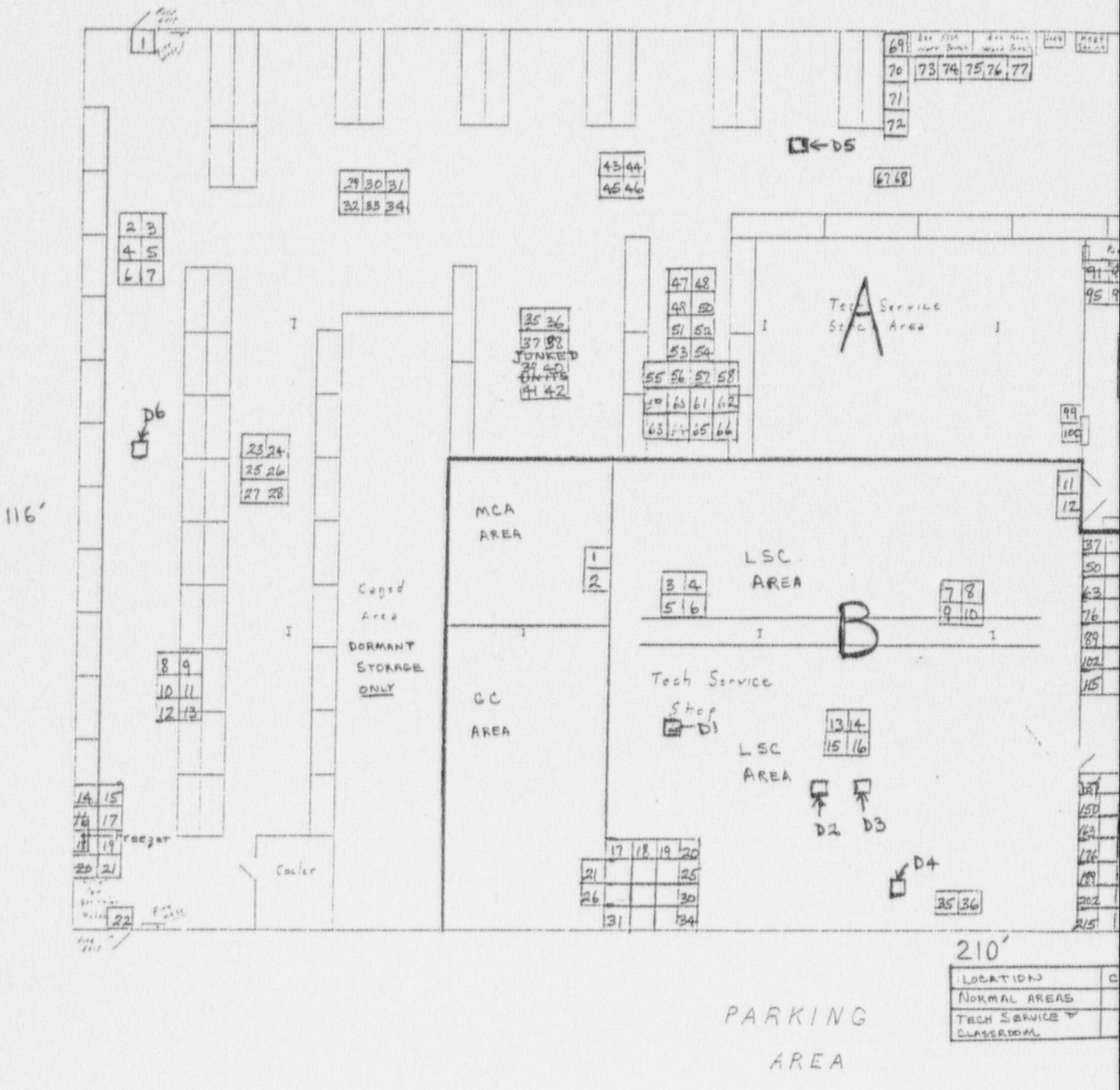
   There is a full time employee designated as regulatory affairs associate reporting to me as well as personnel within the manufacturing and quality assurance function who will maintain and carry out the duties and services of the Radiation Safety Program.

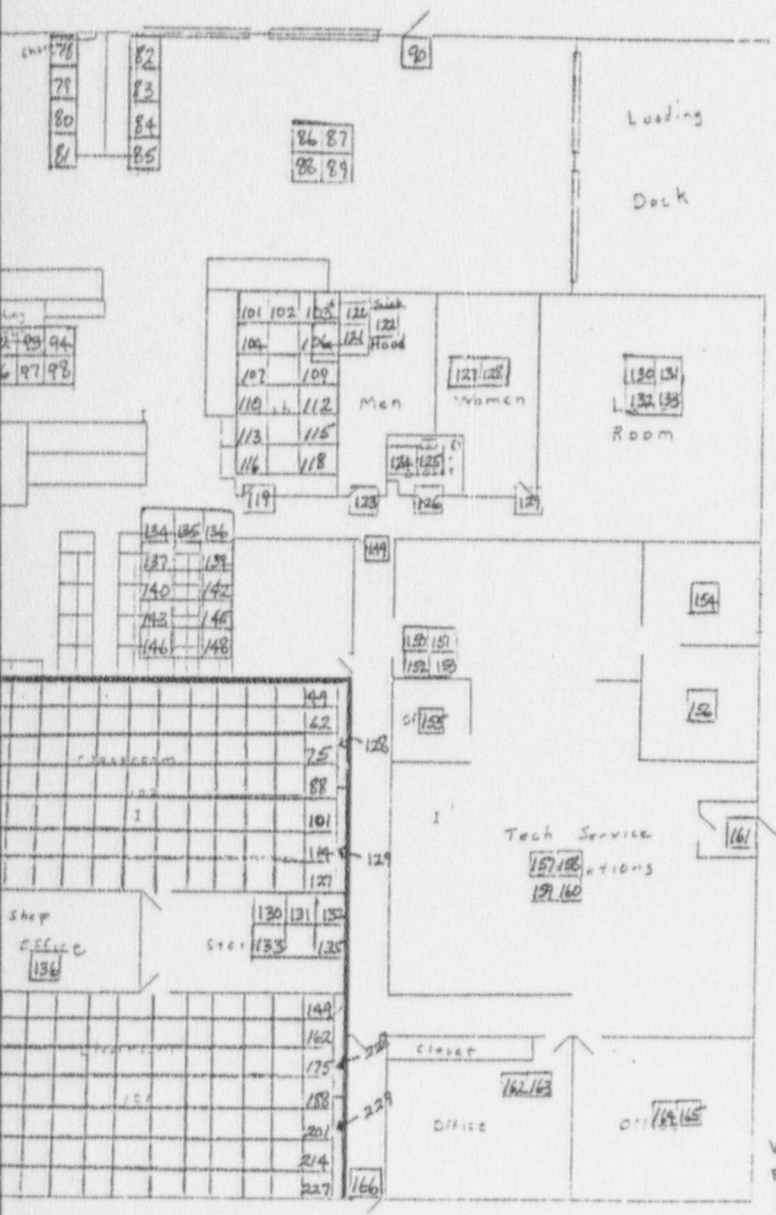
I hope this information clarifies our request for amendment. If you have any further questions, please contact me.

Sincerely,

James J. Capone, PhD
Regulatory Affairs Manager

JC/mke


116'
210'
MCA AREA
LSC AREA
Caged Area
DORMANT STORAGE ONLY
GC AREA
Tech Service Step
LSC AREA
Freezer
Cooler
D1
D2
D3
D4
D5
D6
JUNKED UNITS
PARKING AREA
LOCATION
NORMAL AREAS
TECH SERVICE & CLASSROOM



ISOTOPES PRESENT AND % TOTAL ACTIVITY

H-3 IN H_2O	1 mCi
H-3 IN TOLUENE	20 mCi
H-3 IN SPEC CHEC	21 mCi
C-14 IN SPEC CHEC	23 mCi
C-14 IN TOLUENE	8 mCi
Ni-63 FOIL	145 mCi
H-3 FOIL	575 mCi
Ca-137 IN EPOXY	12.85 μCi
Ba-133 IN EPOXY	24 μCi
I-129 IN EPOXY	9.8 μCi
Fe-55 SEALED	2.5 mCi
Am-241 SEALED	100.045 mCi
Ra-226 CAPSULES	0.6 mCi
C-14 IN STERIC ACID	0.5 mCi
C-14 METHYL PALMITATE	1 μCi
H-3 METHYL PALMITATE	1 μCi

WIPES WILL ALSO BE TAKEN IN THE SINKS LOCATED WITHIN THE LAB & MEN'S REST ROOM, HOOD & VENT, AND AIR CONDITIONER FILTERS

ORDER	# WIPES
A	166
B	229

LOCATION-C	SAMPLE #'S
FILTERS	1 - 4
HOOD	5 - 8
VENT	9, 10
LAB SINK	11 - 13
MEN'S SINK	14, 15
WOMEN'S SINK	16, 17

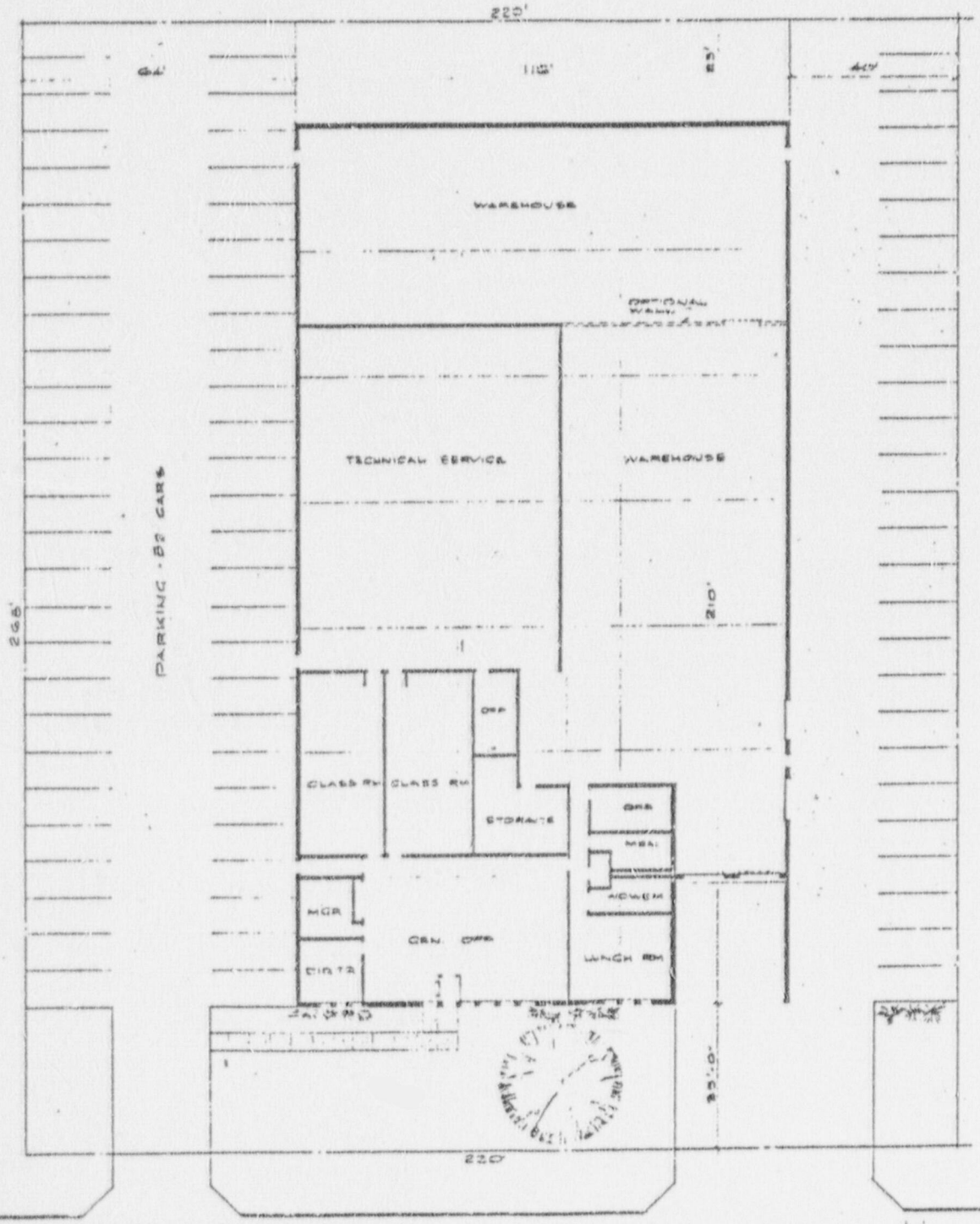
Scale: 1 CM = 1'	Drawn By:	Approved By:	Date: Dec. 1987
Location: 1408 Centre Circle Drive			

8605020022-01

ROOM SCHEDULE

SPACE	DIMENSIONS	AREA SQ. FT. *
Director's Office	15 x 15	237
Manager's Office	13 x 15	199
General Office	35 x 49	1715
Lounge Room	20 x 24	480
Women's Wash Room	8 x 15	122
Men's Wash Room	8 x 15	122
Class Room #1	20 x 43	866
Class Room #2	20 x 43	866
Class Room Storage (Total)	15 x 24	417
Tech Service Office #1	10 x 20	200
Tech Service Office #2	10 x 20	200
Tech Service	82 x 60	4920
Tech Service Storage	32 x 60	1920
Work in Prog. Storage	82 x 41	1328

Bal. Space: Warehouse, Corridors, Docks & Staging Area.



PLAN - PLOT PLAN 1" = 20'

OUTLINE SPECIFICATIONS

CONCRETE: All concrete shall develop a design bearing strength of 3000 P.S.I. in 28 days Foundation and footing bid shall be based on normal construction, assumed to rest on undisturbed soil with bearing capacities of 3000#/sq. ft. at four foot depth below finished grade. Floor slab to be 4" with 6x6x6x6 WWF in office area, 5" with 6x6x6x6 WWF in warehouse, class room and tech service areas. Truck dock, concrete drive to be 7" with 6x6x6x6 WWF.

MASONRY: East, West and South elevations to have 4" face brick with concrete block back-up. North wall to have 4" common brick with concrete block back-up. Allow $95.00/thousand for face brick.

STRUCTUAL STEEL: All structural steel beams, columns, lintels, etc. shall be of type A-36 steel. Short span steel bar joist shall conform to the latest specifications of the steel joist institute. Metal deck shall be 1-1/2", 22 ga. steel. Provide 1-3/4" H.M. doors, metal frames and steel angle frames around all roof openings.

ROOFING & SHEET METAL: 3 ply built-up roof over 1-1/2"F.Ginsulation with built-up cants and steel angle coping. Provide prefinished corrugated metal siding over office as shown.

CARPENTRY: Provide all rough and finished carpentry and hardware. Interior wood doors to be 1-3/4" hollow core, flush paint grade veneer. Interior partitions to be 1/2" drywall on metal studs. Overhead doors to be 8' x 9' & 10' x 10' flush panel on high lift tracks.

ACOUSTICAL TILE: 24" x 48" class 25 mineral fiber acoust. tile, lay-in type, in T-bar susp. system, in all office class rooms, and lunch room. Use 5/8" vinyl coated sheet-rock in T-bar susp. with clips in wash rooms. Ceilings approximately 9' -0" above floor.

GLASS & GLAZING: All glass shall be 1/4" plate. Provide aluminum entrance door and frame, alum. glass frames, anodized. Provide 18" x 24" mirrors over lavs.

PAINTING: Paint with primer and min. one finish coat all office, toilet, class rooms and lunch room walls...all exterior wood and ferrous metals not prefinished. Paint all metal doors and frames, and all interior wood doors.

FLOOR COVERING: Carpet offices, gen. office. (allowance $7/sq.yd.) All other areas except tech service areas and warehouse to receive vinyl asbestos tile, commercial grade.

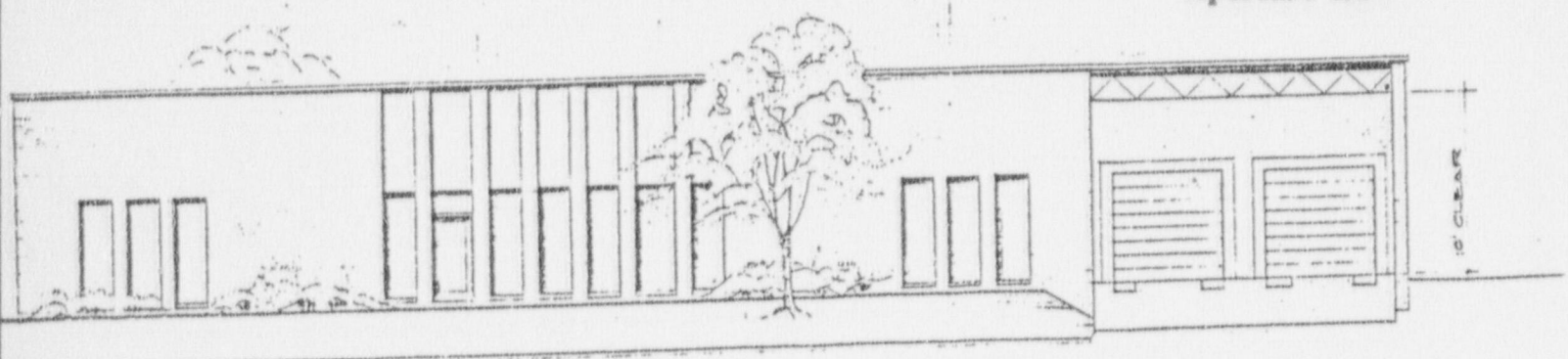
PLUMBING: Provide 6" water service, hot & cold water, fixtures, roof drains, soil & vent lines, sanitary system, mud basin, hangers and sleeves. Provide an approved sprinkler system.

HEATING & A/C SYSTEM: All office, class rooms, lunch room and toilet areas to be heated to 72°F at -10° F outside and air-conditioned cooling to 15 °F below outside temp. Balance of area to be heated with unit heaters to 72° F at 0° F.

ELECTRICAL: Provide 400 amp, 3 phase, 440 volt service.
Lighting levels: Offices and Class Rooms.....75 fc.
Tech Service over work surface....50 fc.
Warehouse.....20 fc.
Contractor to specify fixtures.

SPECIALTIES: Provide and install metal toilet partitions, paper holders and soap dispensers.

PAVING & PARKING: Truck drives will be 3" asphalt over 8" crushed stone base, or 7" concrete. All other parking and drives to be 2" asphalt over 6" stone base. Provide wheel stops and striping.



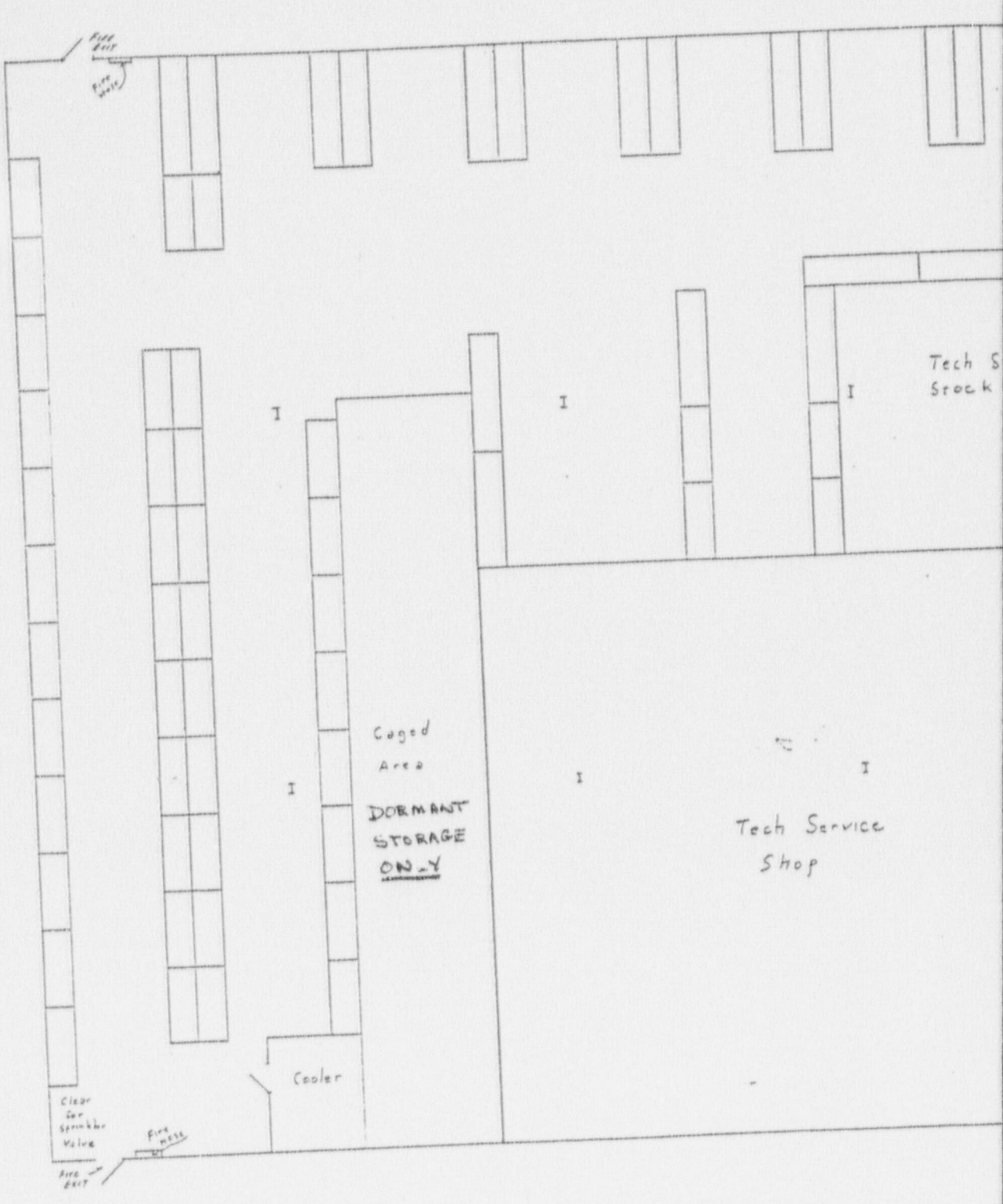
8605020022-02

FRONT ELEVATION

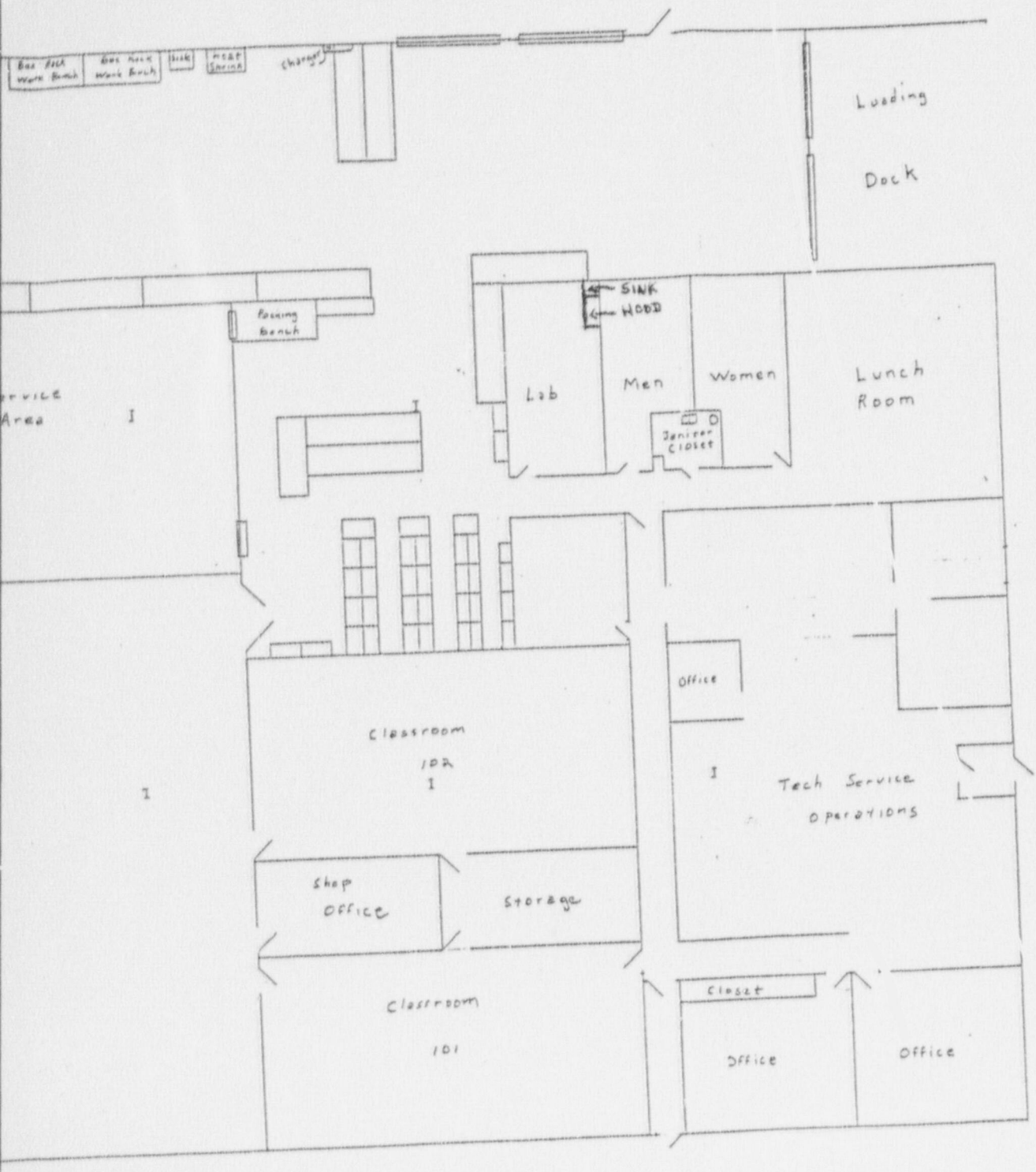
1/8" = 1'-0"

EXHIBIT A-10 REVISED - 6/24/77

DRAWING REQUIRED



CONTROL NO. 80385



Scale: 1/8" = 1'	Drawn By:	Approved By:	Date: Dec. 1983
Location: 1406 Centre Circle Drive			

Packard Instrument Co. 2200 Warrenville Road Downers Grove, IL 60515 Tel. 312-969-6000 TLX 21-0031 FAX 312-969-6511

PACKARD
A Canberra Company

5 June 1986

Mr. George M. McCann
U. S. Nuclear Regulatory Commission
Materials Licensing Section
799 Roosevelt Road
Glen Ellyn IL 60137

1/31/85
030-04098

Re: Amendment of License No. 12-04933-02
Control No. 77998

A
Fee Pd

Dear Mr. McCann:

We request amendment of the above referenced license to designate Leroy F. Booth of Radiation Management Corporation as Radiation Safety Officer, to replace John M. Simonin. Mr. Booth's qualifications for this position are enclosed separately.

Additionally, we ask that Leroy Everett be removed from Condition 12.A as a user of licensed material, as he is also no longer with the company.

Enclosed is a check for $120.00 for the amendment processing fee. Thank you for your assistance in expediting this request.

Sincerely,

James J. Capone, Ph. D.
Regulatory Affairs Manager

ms
encl.

Log June 10
Remitter
Check No. 229633
Amount $120
Fee Category 2.B./3.P.
Type of Fee Materials
Date Check
Date Rec'd 6/11/86
By

860715
REG3 LIC30
12-04933-02 PDR

2pp

RECEIVED JUN 9 1986
JUN 9 1986
REGION III

CONTROL NO. 81472

CANBERRA
RMC
Radiation Management Corporation, 1175 Tower Road, Schaumburg, IL 60195 (312) 310-8650

CANBERRA/RMC
PROFESSIONAL STAFF

LEROY F. BOOTH, C.H.P.
MANAGER, MIDWEST REGIONAL OFFICE
NUCLEAR SERVICES DIVISION

Mr. Booth joined RMC in January of 1979 as a Senior Health Physicist, and was appointed Midwest Regional Manager in June of 1980. He is responsible for providing health physics consulting assistance to clients. Specific responsibilities have been in RMC's whole body counter design, development and operation programs, emergency assistance programs, radio-analytical measurement program, and remedial action programs. He is also responsible for office and project management, development and supervision.

Mr. Booth received his B.S. in Chemistry from Northern Illinois University in 1964, and has performed graduate studies in Nuclear Science and Engineering at Catholic University. Prior to his position at RMC, he was responsible for implementing and directing the contract health physics program at Goddard Space Flight Center. Prior to GSFC, Mr. Booth was a Staff Health Physicist at NUS, providing consulting services in areas such as procedure preparation, training materials preparation, program reviews, instrumentation evaluations and waste disposal for nuclear power plant clients; a Senior Health Physicist at U.S. Naval Research Laboratory responsible for performing radionuclide analyses and TLD research, and a Physical Science Assistant in the Radiological Safety Department at the Armed Forces Radiobiology Research Institute.

Mr. Booth is a member of American Nuclear Society and Health Physics Society, Midwest and Baltimore-Washington Chapters. He was certified by the American Board of Health Physics in 1972. He served as a member and vice chairman and chairman of the ABHP Panel of Examiners. Mr. Booth has authored or co-authored numerous articles, papers and technical reports on various health physics related topics such as thermoluminescence dosimetry, field radiological measurements and assessments, and internal dosimetry.

[100,100]113

CONTROL NO. 81472

2

JUN 17 1986

Packard Instrument Company, Inc.
ATTN: James J. Capone, Ph.D.
Regulatory Affairs Manager
2200 Warrenville Road
Downers Grove, IL 60515

We have reviewed your letter dated June 5, 1986 requesting an amendment to License No. 12-04933-02 and find that we will need additional information.

Regarding your request to add Leroy F. Booth as Radiation Safety Officer, it is our understanding that Mr. Booth is not a full time employee of Packard Instrument Co., Inc., but rather is a part time consultant. Therefore, in order for us to determine the effectiveness of this arrangement, please provide a description of Mr. Booth's availability to the program with regard to:

1. Time devoted to accomplishing the RSO's duties and responsibilities;

2. Response to emergencies (i.e., on-site contact or time needed to respond);

3. Provisions for an alternate, qualified RSO when Mr. Booth is unavailable; and

4. Provisions for an on-site contact person and sufficient staff to support the Radiation Safety Program.

If you have any questions or require clarification on any of the information stated above, you may contact us at (312) 790-5625.

We will continue our review of your application upon receipt of this information. Please reply in duplicate, within 30 days, and refer to Control Number 81472.

Sincerely,

Original Signed By
Evelyn R. Matson
Materials Licensing Section

8610010101 860715
REG3 LIC30
12-04933-02 PDR

RIII
Matson/pg
06/17/86

UNITED TECHNOLOGIES PACKARD

2200 Warrenville Road
Downers Grove, Illinois 60515
(312) 969-6000
Telex: 21-0031
Facsimile (312) 969-6511

Packard Instrument Company

16 December 1985

U.S. Nuclear Regulatory Commission
Materials Licensing Section
799 Roosevelt Road
Glen Ellyn, Illinois 60137

'85 DEC [illegible] RECEIVED

Re: Amendment to License No. 12-04933-02

Gentlemen:

We request amendment of our above referenced license for the following changes:

1. Add Dorothy Mrkvicka, Ken Neumann, Marc J. Ellis, James R. Norris, Ray O'Day, and John "Marty" Simonin as users of radioactive material at our facilities. The resumes of these individuals are enclosed with this application. Stan Huber, who is currently serving as Radiation Safety Officer (R.S.O.) on our license should also be added as a user. His resume was previously submitted and is on file with the NRC under NRC License 12-17503-01 and IDNS under License IL-00317-01. The addition of these seven individuals should rectify our current situation of having only two persons, Stanley De Filippis and LeRoy Everett listed as users. Mr. De Filippis and Dr. Everett are to remain on our license, which will provide a total of nine (9) authorized users/supervisors. J. A. Gibbs and S. van Cauter are to be removed from our license.

2. Designate John "Marty" Simonin as Radiation Safety Officer (R.S.O.) and redesignate Stan A. Huber as Alternate Radiation Safety Officer, who would be available to serve as R.S.O. during vacations or any extended absences by Mr. Simonin. Mr. Huber has served as our nuclear consultant for over eight years and has become most familiar with our operations over the past eight months of excellent performance as our R.S.O. We wish to retain that resource on our license.

3. Delete our 1406 Centre Circle Drive facility from our license. We are consolidating the functions performed at that location into our main plant. We have performed a "close-out" radiation survey and wipe tests of the Centre Circle facility. The results and description of procedures and counting equipment we used are enclosed with this amendment request. It is our intent to release the Centre Circle building to its owner for unrestricted use.

4. The radioactive materials at the Centre Circle facility have been primarily incorporated into existing radiation storage areas at our main plant at 2200 Warrenville Road. The changes resulting from this move include the following:

RECEIVED
DEC 23 1985
REGION III

DEC 23 1985

Applicant: Jan 4 '86
Check No. 068108 $120
Amount/Fee Category 3B 3P/3N
Type of Fee amd
Date Check Rec'd 1/8/86
Received By [illegible]

~~8605020022~~ 860307
REG3 LIC30
12-04933-02 PDR

CONTROL NO. 80385

51pp.

UNITED TECHNOLOGIES PACKARD

a) Gas Chromatograph ECD's are now stored in Room M-129.

b) Ra226 standards from Centre Circle are now stored in Room M-130.

c) H3, C-14, I-129, Cs-137 and related stock from Centre Circle is now in a secured dead end corridor in the center of the warehouse area in our main plant. This is a new storage area.

d) Our former PCB Board Dept. in Rooms M-21, M-22 and M-23 has now been converted to LSC Service Shop area where primarly C-14 and H-3 standards and counting vials are used.

Our Regulatory Affairs Manager is aware of these changes and has instructed lab survey personnel to make any appropriate changes in routine radiation surveys.

We will appreciate any assistance which can be given to expedite this amendment request. Please feel free to call Marty Simonin in Regulatory Affairs at (312) 969-6000 if there are any questions. Our check for the amendment fee is enclosed.

Thank you.

Sincerely,

Gerhard H. Kremer, PhD
Vice President & General Manager

rc
Encl.

UNITED TECHNOLOGIES PACKARD

2200 Warrenville Road
Downers Grove, Illinois 60515
(312) 969-6000
Telex: 21-0031
Facsimile (312) 969-6511

Packard Instrument Company

December 11, 1985

Michael Ewan
Illinois Department of Nuclear Safety
1035 Outer Park Drive
Springfield, Illinois 62704

Ref: License #IL-00238-01

We have enclosed, per your request, further information on the closure of U.T. Packard's Centre Circle Drive facility which is licensed under IL-00238-01. The following information is contained in the attachment:

(1) The Eberline SPA-2 gamma scintillator detector has a 1" by 2" NaI thallium activated crystal.

(2) The guidelines that we will be utilizing for the release of the building for unrestricted use are those established by the NRC as previously stated in our November 15, 1985 letter.

(3) The grid method that will be used for conducting the wipes along with the map of the area. We will be taking additional wipes (approx. 20) on general areas not presently indicated on the map to indicate that we have checked additional areas not suspected of material usage. Copies of the results along with the revised map will be forwarded to you upon completion.

(4) The brochure and specification sheets for the 4000 series LSC units in which one of our current Models will be used, depending upon availability.

You realize that the only Illinois licensed material used in the building was Ra-226 pellets used in our LSC units in for repair. If there was a leaker, etc., the units background levels would be elevated and quickly detected.

We hope this above information meets with your approval and that all matters have been resolved. If we may ever be of further assistance, please feel free to contact this office.

Very truly yours,

John M. Simonin
Regulatory Affairs Manager

cc: G.H. Kremer
S. Huber
P. Special

Enclosures

na

SECTION I

GENERAL

A. PURPOSE

The Eberline Instrument Corporation SPA-2 is a scintillation type radiation detector. The crystal installed determines what type of radiation is detected. Many types and sizes of crystals are available, and the one used on a particular detector is shown by a decal on the end cap.

The detector consists of a photomultiplier tube, a socket and dynode network assembly, and a crystal all contained inside an extremely rugged, waterproof housing.

B. SPECIFICATIONS

1. MAXIMUM VOLTAGE: +1500 volts dc.

2. OPERATING VOLTAGE: Any positive dc voltage up to maximum rating. Optimum voltage depends on energy of radiation to be detected, energy of radiation to be rejected, particular photomultiplier characteristics, cable length, and input sensitivity and impedance of counter. Nominal for most applications is 900 to 1200 volts.

3. CURRENT: Total resistance is 148 megohms, so current drain is 8.1 microamps at +1200 volts.

4. CONNECTION: Single coaxial cable with positive high voltage and ground. Load resistor and coupling capacitor must be in counter. Mating connector is EIC Model CP-1.

5. OUTPUT: Negative pulse on high voltage line. Amplitude is dependent on energy of radiation, high voltage applied, cable length, and input impedance of counter.

6. MAXIMUM COUNTING RATE: Approximately 10^6 counts per minute.

7. SIZE: 2 inches diameter x 9 1/8 inches length. (Length for 1 inch crystal)

8. WEIGHT: Approximately 1 1/2 pounds.

9. FINISH: Gray hammertone painted body, anodized aluminum end cap and chrome-plated connector.

10. CHARACTERISTICS WITH VARIOUS CRYSTALS:

a. NaI (T1): With 3 foot cable and counter with 10 millivolt sensitivity, the lower knee of the Co^{60} plateau is approximately 900 volts, and the noise threshold is approximately 1300 volts. Slope is less than 2% per 100 volts. Counting sensitivity on plateau with different thickness crystals is approximately as follows:

THICKNESS	CPM per mr/hr
1/4 inch	35,000
1/2 inch	75,000
1 inch	120,000
2 inches	180,000

b. Slow Neutron, Boron with ZnS(Ag) activator.

NE400: Natural Boron
NE401: Same except enriched to 55% B^{10}.
NE402: Same except enriched to 90% B^{10}.


CRYSTAL
1 IN. NaI(Tl)
X 2 THK
GAMMA

ATTACHMENT A

UNITED TECHNOLOGIES PACKARD

30 August 1985

TO: M. Simonin

RESUME SUMMARY FOR: Dorothy Mrkvicka

FROM: D. Mrkvicka

Education:

Bachelor of Arts degree, Chemistry major.

Courses completed and seminars attended:

1984 - Chemical Safety Seminar presented by American Scientific Products.

1985 - Packard Instrument Instruction Program; Radiation Safety, USNRC Regulations, Use of Survey Meters, Radioactive Material Licenses.

1985 - Packard Instrument Co. Safety Training Class; "Right to Know".

1985 - ACS symposium; Emergency Response, "Right to Know," MSDS.

Experience:

Employed by Argonne National Laboratory as Analytical Chemist and Mass Spectroscopist for 4 years. During this time worked with radioactive substances and completed course in nuclear radiation.

Employed by College of DuPage as Laboratory Supervisor and Chemistry Instructor for 10 years.

Dorothy Mrkvicka

rc

The following is a summary of the isotopes with which I have worked since December, 1979 while employed at Packard Instrument Co.

Radionuclide	Isotope Form	Max. Amount(mCi)
Carbon-14	unsealed	5.0
Tritium	"	5.0
Radium 226	sealed	2.0
Americium 241	"	1.3
Iodine 129	"	0.005
Cesium 137	"	0.025
Barium 133	"	2.0

UNITED TECHNOLOGIES PACKARD

30 August 1985

TO: M. Simonin

FROM: D. Mrkvicka

RESUME SUMMARY FOR: Dorothy Mrkvicka

Education:

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Courses completed and seminars attended:

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Employed by College of DuPage as Laboratory Supervisor and Chemistry Instructor for 10 years.

Dorothy Mrkvicka

rc

UNITED TECHNOLOGIES PACKARD

KN - 37
4 September 1985

TO: M.Simonin

FROM: K. Neumann

SUBJECT: NRC License Biography

EDUCATION

1982 B.S. Degree - Biological Sciences, University of Illinois, Chicago.

1984 B.A. Degree - Chemistry, University of Illinois, Chicago.

Presently attending Oakton Community College, Des Plaines, in the Marketing Management curriculum. Estimate completion in Spring 1988.

WORK HISTORY

Employed by Packard Instrument Company since 8 October 1984.During this time, I have attended seminars on Radiation Safety (7 January 1985) and Compressed Gas Safety (8 May 1985)

Ken Neumann

MARC J. ELLIS

Resume Summary 9-85

Education

B.A. Degree - Biology 09/76-05/80 — Rutgers University, New Brunswich, N.J.

Includes courses in Physics, Chemistry, Calculus

Working on Master's Degree in Computer Science

Packard Job Title: Associate Microbiologist, Started March, 1981 as Assoc. Immunologist

Nuclear Materials Experience and Radiation Safety Training

Certificates of successful completion of Packard Radiation Safety Training Courses 16 May 1984 and January 1985 (16 hours total).

Over four (4) years working experience with radioactive materials used at Packard-Downers Grove, IL. This primarily involved working in Instruments Division and R & D Lab with C-14 and H-3, below 100 mCi activity, various other radionuclides below1 millicurie activity, and Ra 226 and Ni 63 sealed sources ranging between 10 microcuries to 10 millicuries.

30 August 1985

James R. Norris

Qualifications for supervising employees working with radioactive and other hazardous materials.

Background:

1 Year H.S. Biology
1 Sem. College Biology
1 Year H.S. Physics
1 Sem. College Theoretical Physics
1 Year College Chemistry

Six years at supervisory experience in the battery manufacturing business where hazards from sulfuric acid and lead exposure existed.

Current Position:

Almost two years at Packard where I have received both formal training and OJT on the handling, manufacturing and shipping of hazardous materials.

Formal training includes classes on; Principals of Radioactivity (5-15-84), UPS Guide for Shipment of Hazardous Materials (9-15-84), MDSD Training (3-5-85), Compressed Gas (8-8-85).

OJT; Observance of methods and reading of SOP's on the manufacturing of radium pellets, I129 and Ces 137 rod sources and H3 and C14 liquid standards.

Continued personal interest and reading in the fields of Physics, Chemistry, Evolution, Ecology and other natural sciences.

CONTROL NO. 80385

Ray O'Day

Education

B.S. Biology, Rutgers University 1957
Field Medical Service School 1961
Clinical Laboratory School 1962
Tissue Culture and Tissue Bank School 1963
Handling and use of Radioactive Material,
Groningen, The Netherlands 1983
Principals of Radioactivity
USNRC Form 3 1984

Experience

Surgical Team, 2nd Battalion 6th Marines 1961
Instructor, Tissue Culture School,
Naval Medical Research Institute 1962-1967
Radiochamistry experience at Packard Instrument
Company, Handle 3H, 14C, 125I in Research Lab
1983-1985.

JOHN MARTIN SIMONIN

1122 Needham Road
Naperville, IL. 60540

(312)355-5595 (Home)
(312)969-6000 (Office)

EXPERIENCE

1982 to Present — Transportation Coordinator. Illinois Department of Nuclear Safety, Office of Waste and Transportation Management.
Implement the Department's statutory regulations for radioactive materials transportation.
Planned and conducted training of Department personnel for spent fuel inspections and escorting.
Coauthored the Illinois Spent Nuclear Fuel Transportationpamphlet for the U.S. Department of Transportation (USDOT).
Coordinated enforcement of regulations with State and Federal agencies.
Planned, developed, and established a computer data storage system for radioactive material transportation incidents and accidents.
Planned and conducted training programs for Illinois State Police (ISP) on radiation survey of shipments and instrumentation.
Coordinated a three-year USDOT contract with other State agencies in the development of a State Hazardous Materials Enforcement Development Program (SHMED).

1980 to 1982 — Health Physicist. Illinois Department of Nuclear Safety, Office of Radiation Safety.
Authored four Nuclear Regulatory Commission (NRC) NUREG reports on transportation of radioactive materials within the State of Illinois from 1977 to 1981.
Established computer data storage and retrieval system for laser registration and ISP radiological vehicle inspection data.
Trained ISP hazardous materials troopers in USDOT regulations for radioactive materials.
Coordinating member of Department's radiological emergency response team.
Member of four-state NRC workshop committee on industrial radiography.

1975 to 1980 — Health Physicist. Illinois Department of Public Health, Division of Radiological Health.
Supervised the non-medical x-ray compliance and nonionizing radiation program.
Trained and evaluated regional personnel in facility inspections.
Coordinated activities of fifteen regional personnel.
Revised radiation regulations and data processing procedures.
Coordinated transportation study with ISP under contract with the NRC and USDOT.

1974 to 1975 — Industrial Hygiene Engineer. Illinois Department of Labor, Division of Safety Inspection and Education.
Performed quantitative and qualitative evaluations of air contamination, ventilation, and noise conditions present in industrial working environments.

John Martin Simonin (cont'd)

Served as industrial hygiene engineer under Federal Occupational Safety and Health Administration (OSHA) contract.

1974 — Substitute Teacher. Springfield School District 186.

1969 to 1974 — Chemist. Illinois Department of Transportation, Bureau of Materials and Physical Research.
Conducted qualitative and quantitative evaluations following the American Society for Testing Materials (ASTM) procedures.

EDUCATION

Southern Illinois University (SIU), Carbondale, Illinois.
Bachelor of Science, 1969. Major: Chemistry.

SIU Carbondale and Edwardsville, Illinois.
Graduate work in Educational Psychology (24 hours)

SUPPLEMENTAL EDUCATION

State Data Processing Center: Various computer programming courses.

State Personnel Department: "Executive Development Program for Public Administrators".

OSHA Institute: Courses in Industrial Hygiene; Industrial Safety; and Recognition, Evaluation, and Control of Noninizing Radiation.

Lincoln Land College, Springfield, Illinois.
Course work in data processing.

NRC sponsered courses in emergency response, radiography, and licensing.

DeVry Technical Institute, Chicago, Illinois.
Electronics Communication course.

UNITED TECHNOLOGIES PACKARD

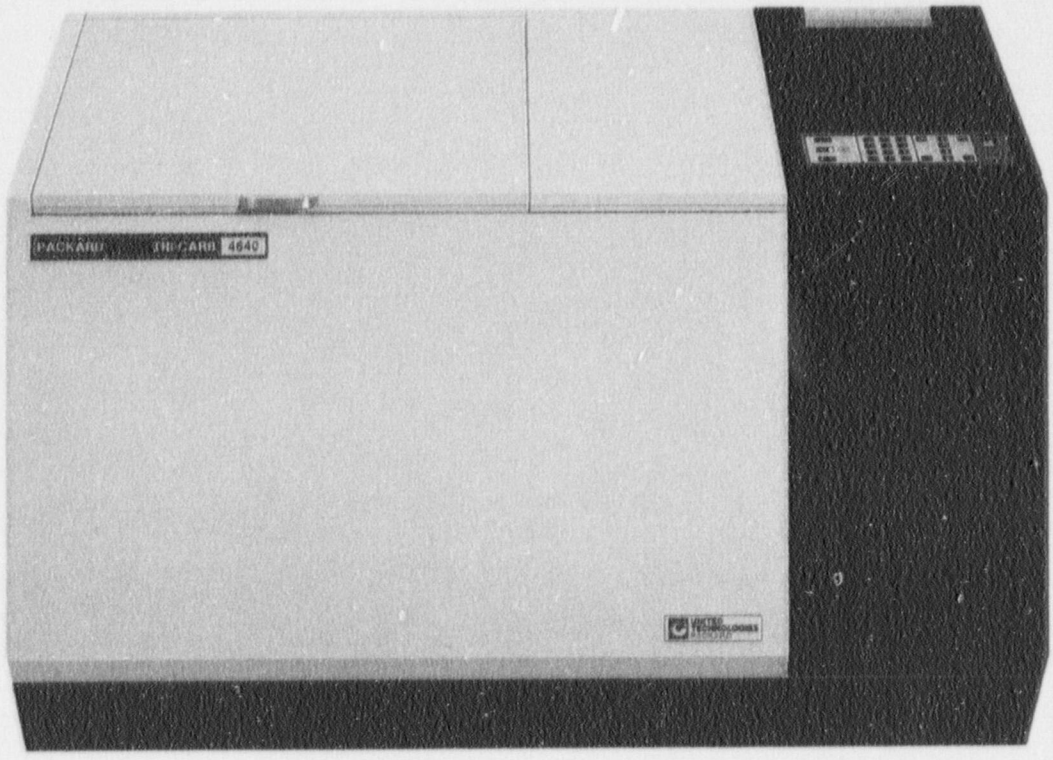
Packard Instrument Company
2200 Warrenville Road
Downers Grove, Illinois 60515
312/969-6000
Telex No. 27 0061

Packard Instrument International S.A.
Renggerstr. 3
CH-8038 Zurich
Switzerland
Tel. 01/481 69 44

UNITED TECHNOLOGIES PACKARD

High technology is the common denominator of all we do.

Tri-Carb® 4000 Series
Liquid Scintillation Systems



PACKARD

Innovative Design

The complex life science work of today demands reliable, flexible, cost effective, state-of-the art instrumentation.

Packard Instrument Company has a line of liquid scintillation counters designed to meet these demands. After 30 years and hundreds of thousands of life science investigations, Packard remains the leader in nuclear scintillation counting systems, with a worldwide reputation based on high performance, ease of operation, reliability and proven superiority.

Packard has called upon all its resources and experience in bringing to market new Tri-Carb 4000 Series liquid scintillation counting systems.

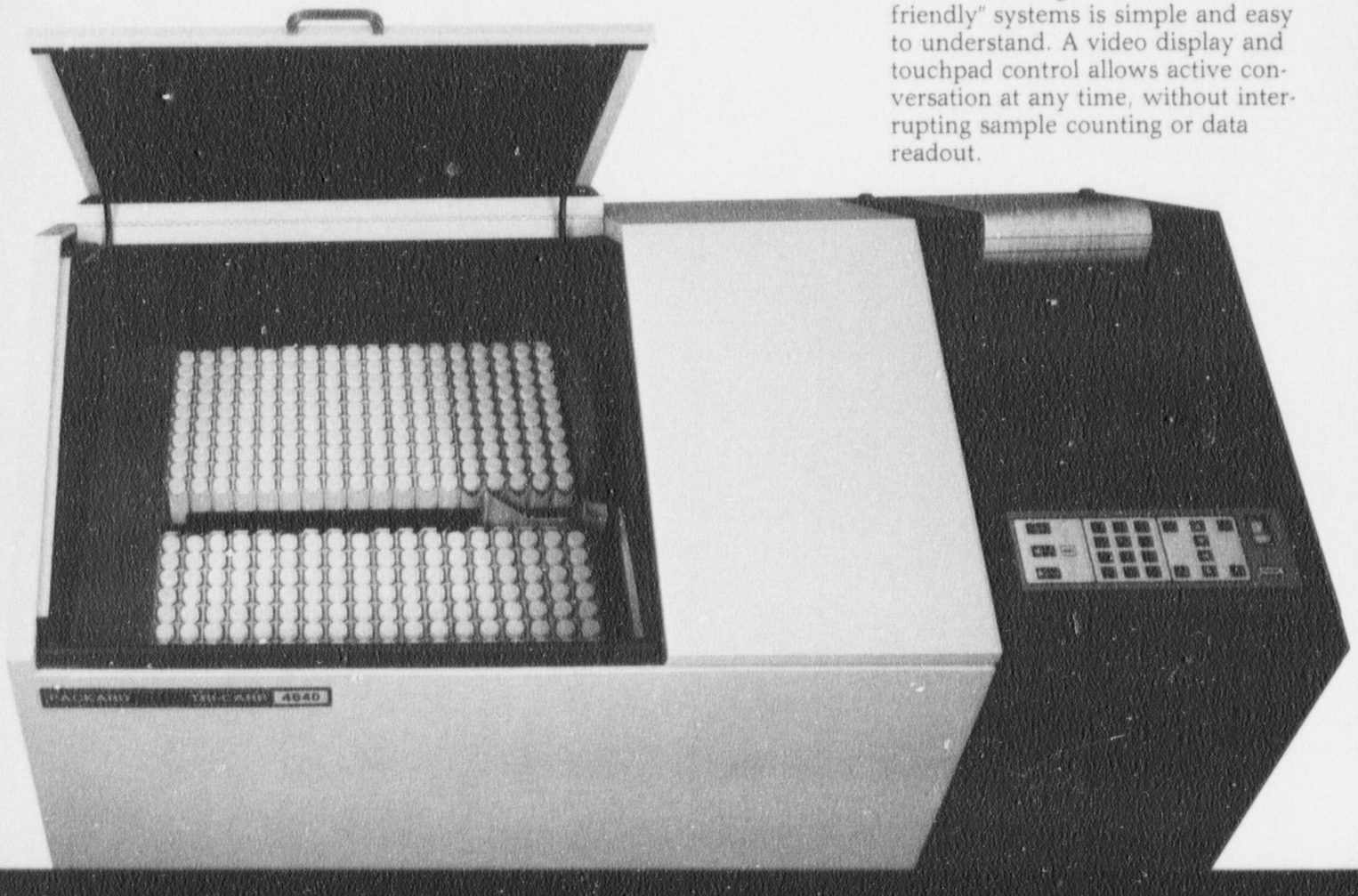
Among the many *standard* features of Packard's Tri-Carb systems are a video display screen and self-test diagnostics.

Designed with high performance detectors (PMT's) and digital electronics, these liquid scintillation systems offer optimum sensitivity and stability for radioactive measurements. These qualities are maintained for the life of every Tri-Carb system by an automatic self-normalization and calibration program.

The Tri-Carb 4000 Series systems each use a convenient and labor-saving cassette sample changer. Sample handling is minimized by loading and unloading groups of samples in cassettes. Samples are up-loaded to prevent dust or contamination from affecting performance. The microprocessor-controlled sample transport system, provided with automatic anti-jam features on all functions, is bi-directional for ease of loading and unloading.

As an optional multi-user instrument, different sample batches can be measured with assorted counting parameters. Sample batches are identified by program inserts mounted on the leading cassette of each batch. Inserts incorporate cycle control, and the visual inspection informs an operator if space is available for more samples.

Communicating with these "user-friendly" systems is simple and easy to understand. A video display and touchpad control allows active conversation at any time, without interrupting sample counting or data readout.



Conversing with Confidence

Communications

After count programming, the only required interaction with the system is loading and unloading samples or cassettes.

The Tri-Carb 4000 systems' video display continuously projects information on the current status of the system. It displays the program #, sample #, counting time, time of day, date, and the CPM in each of the three regions. The CPM of the regions is updated every six seconds. If region limits are changed during a measurement, the next six-second update displays the effect of the change. Conversation is via a sensor control panel.

Defining, editing, or modifying a program is a simple matter of positioning a display cursor (highlight) to the appropriate counting parameter and entering a response. Response restrictions accompany the questions to insure valid entry.

Multi-User, Time Savings

Microprocessor control allows multiple functions to be performed simultaneously.

The 4000 Series systems store up to 15 different user-defined programs, which is more than any other competitive system. Communicating with these responsive systems is simple and easy. For your convenience, a video display and touchpad control allow interactive programming, without interrupting any ongoing operations. Your samples will be counted according to your custom program or programs. All your program parameters and storage needs are self-contained within the 4000 Series; no need for additional disc storage.

Versatile data reduction is provided in each of the measuring programs with normalized results. Also provided are repeat and replicate sample counting with averaging, % of standard and background subtract.

In addition to automatic start following a power failure, the system incorporates a self-check on its microprocessor sequence. Battery support preserves all programs for a period of 72 hours.

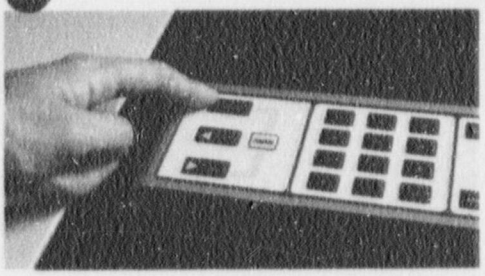
Diagnostic programs displayed on the video screen allow monitoring of all system functions.

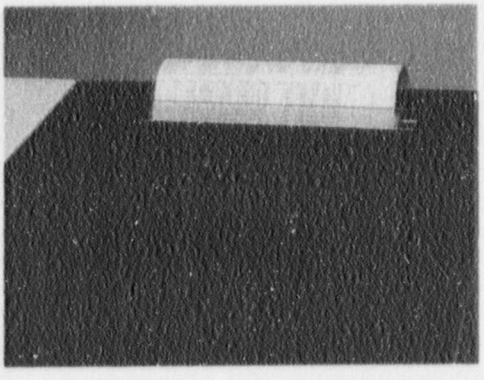
Counting with Confidence

PrioSTAT™ Interrupt

Tri-Carb systems feature an automatic cassette changer and an optional manually-operated PrioSTAT. The optional PrioSTAT system is a simple means of interrupting automatic counting to determine activity in samples without affecting the readout. At the end of this mode, the system automatically returns to the interrupted sample.

One benefit of PrioSTAT, available only from Packard, is the ability to perform spectral search while sample counting. It also provides a unique method to determine region limits for a sample, and by reverse-AEC, automatically obtain the unquenched region limits. The versatility of PrioSTAT and SPECTRALYZER even allows for radionuclide "identification".



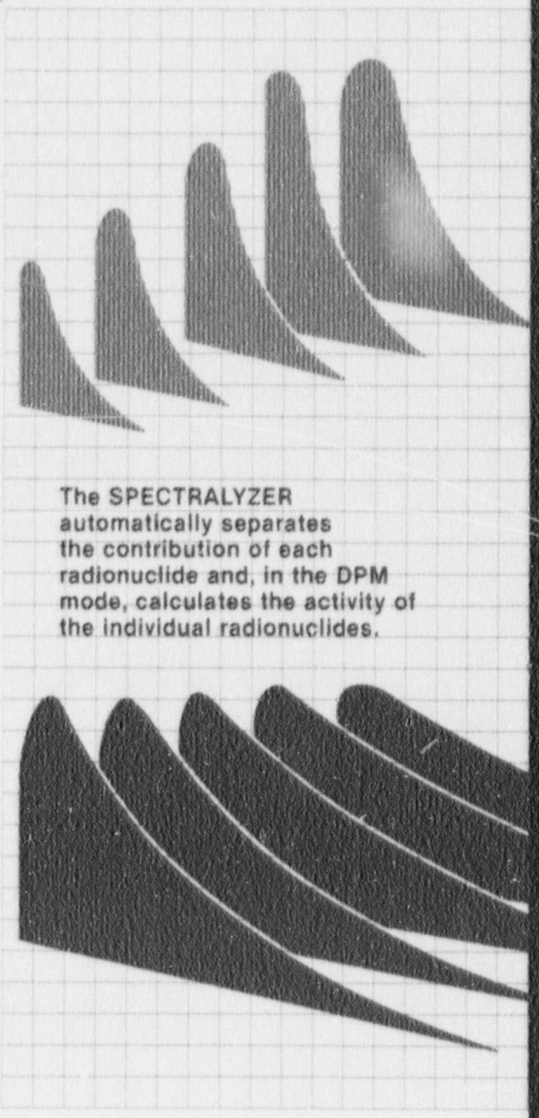


Simplicity with Sophistication

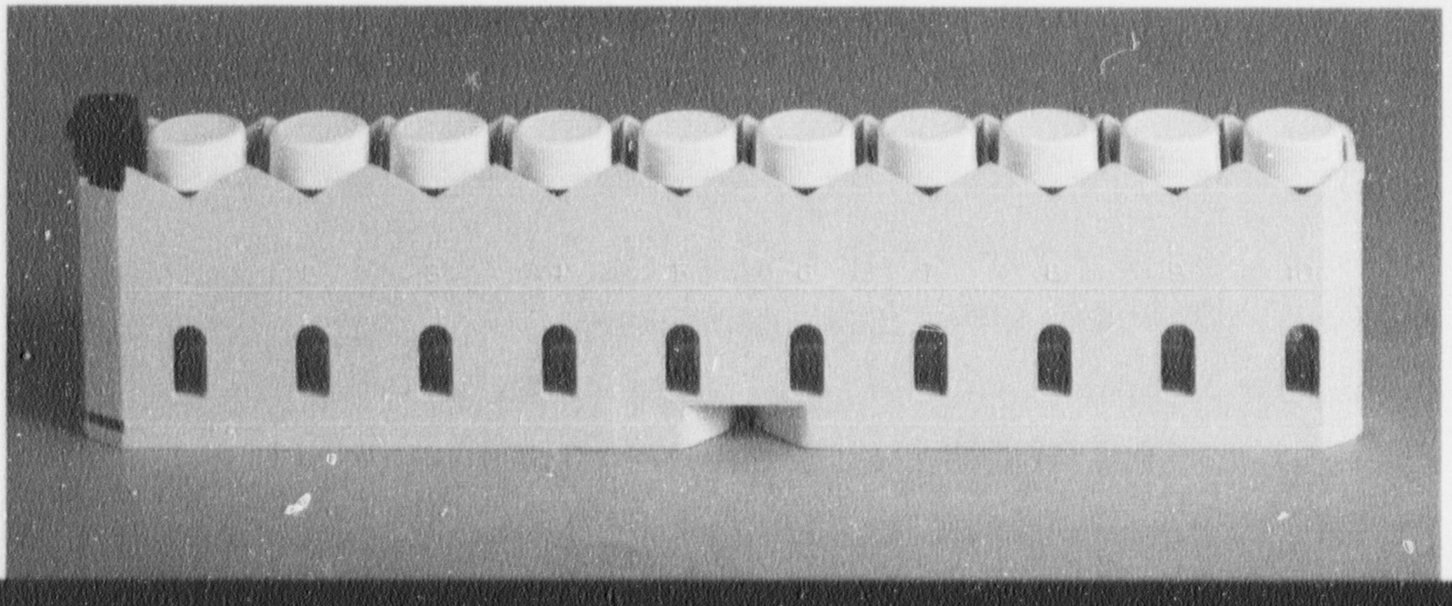
The unique SPECTRALYZER™ storage of all sample information in Tri-Carb instruments has made gain and discriminator settings, concerns of the past. The Packard Tri-Carb system is linear with the SPECTRALYZER calibrated in energy (keV), providing the ability to enter the radionuclide Bmax as the measuring region of interest. Three regions are provided to extract the data stored on the SPECTRALYZER, for single or multiple-labeled samples. For convenience, regions are predetermined for 3H, 14C, 125I and 32P, or 3H/14C and 3H/32P in dual label. There is also the flexibility to determine individual regions, even while sample counting.

Advanced electronics technology and the linear SPECTRALYZER allow spectral analysis of each sample's data, providing a monitor of quenching as well as a measure of counting efficiency. The analysis produces an index more precise than earlier techniques. The system can calculate the Spectral Index of the Sample data (SIS) and the Spectral Index of the External Standard data (SIE).

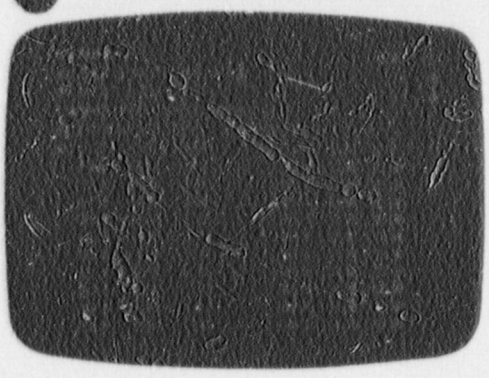
Packard systems each use a convenient and labor saving cassette sample changer. Sample handling is minimized by loading and unloading groups of samples in cassettes. Samples are uploaded to prevent dust or contamination from affecting performance. The microprocessor controlled sample transport system, provided with automatic anti-jam features on all functions, is bidirectional for ease of loading and unloading.



The SPECTRALYZER automatically separates the contribution of each radionuclide and, in the DPM mode, calculates the activity of the individual radionuclides.

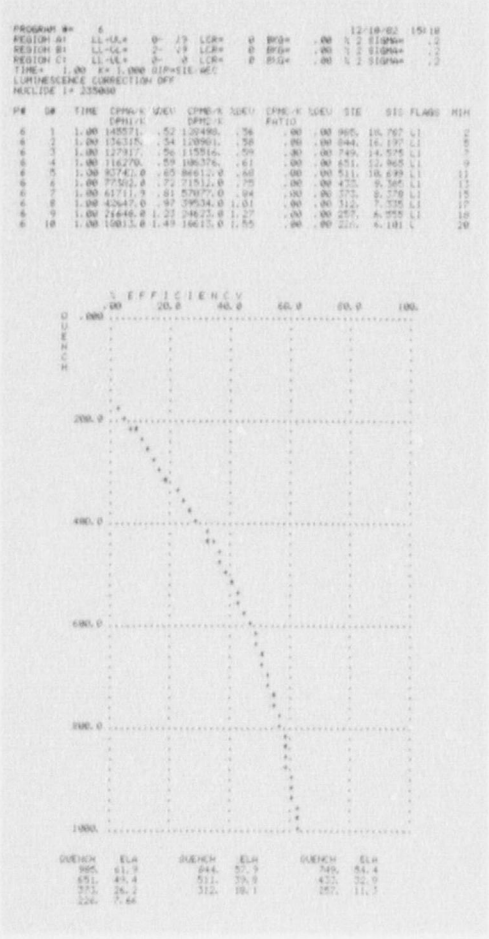


Special Features



Results in DPM

The DPM option provides activity of samples in Disintegrations Per Minute calculated from the efficiency correlations based on SIE or SIS. DPM for single or dual-labeled samples includes curve plotting and replotting. Each program has the capacity to store dual label correlations. Curve editing and copying expands the system capability.



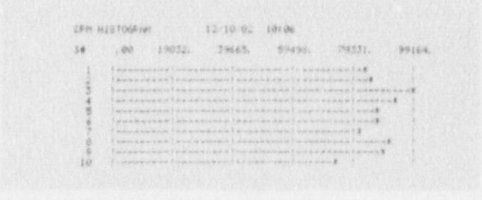
Luminescence Detection and Correction (LDC)

A unique optional Packard feature for the Tri-Carb Systems is luminescence detection. Corrected sample results are obtained for each sample by subtracting luminescence events from the SPECTRALYZER. This correction is programmable through conversation and represents the most sophisticated method obtainable.

Chromatography Data Reduction

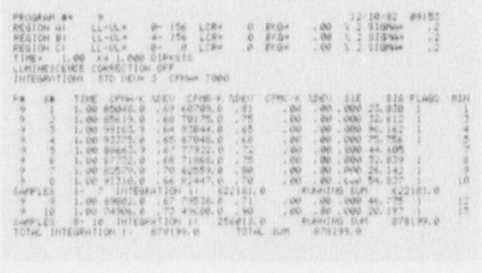
Histogram

An optional graphic presentation of the fractions in your run is plotted following the normal output. The histogram plots CPM or DPM of single label samples and for dual label simultaneously prints both plots. You can set the scale or allow it to autorange.



Integration

Used with or without Histogram, the Integration option allows you to select a sensitivity and integrate CPM or DPM in each peak. You set the threshold. Integration can be applied to both isotopes in a dual label run. The sum of all peaks is presented at the end of the run.



Temperature Control

The optional refrigeration system, available on Models 4530, 4550, 4640, and 4660 provides the necessary sample stabilization for laboratories whose samples may require absolute temperature control.

Automatic Efficiency Control (AEC)

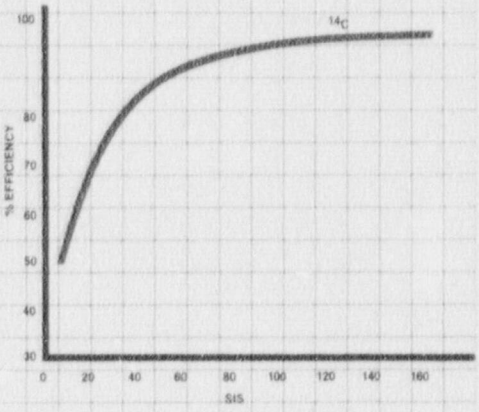
To maintain high efficiency and insure accurate results, Packard pioneered the development of AEC. AEC insures that each sample is counted according to the region limits (keV) entered by the programmer. AEC retains this criteria independent of the various quench conditions in the samples. It is applicable to single or multiple-labeled samples. More precise results are achieved as the background and spillover in multiple label samples are controlled.

The concept of SIE, exclusive to Packard, is based on the ^{226}Ra external standard source. It has proven to be accurate, reproducible, and reliable. It takes seconds to determine. Should the precision of the SIE fall below approximately two percent, because of high quenching with low volume samples, results are flagged – a warning that the test may be suspect. (Optional on 4400 Series Systems.)

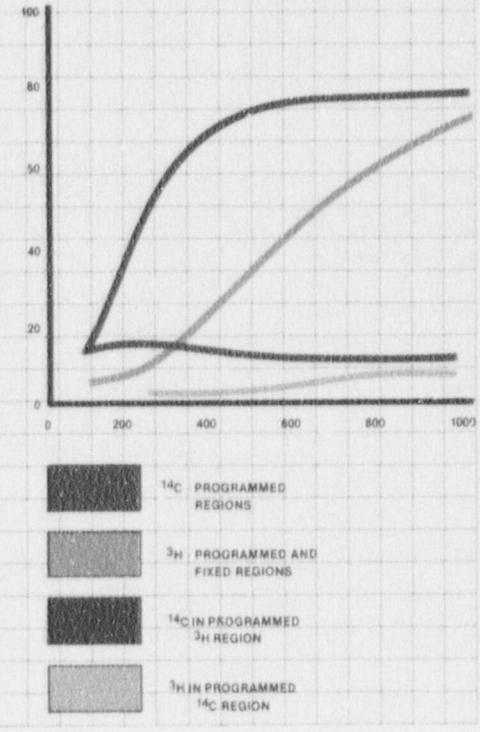
Self-Normalization and Calibration (SNC)

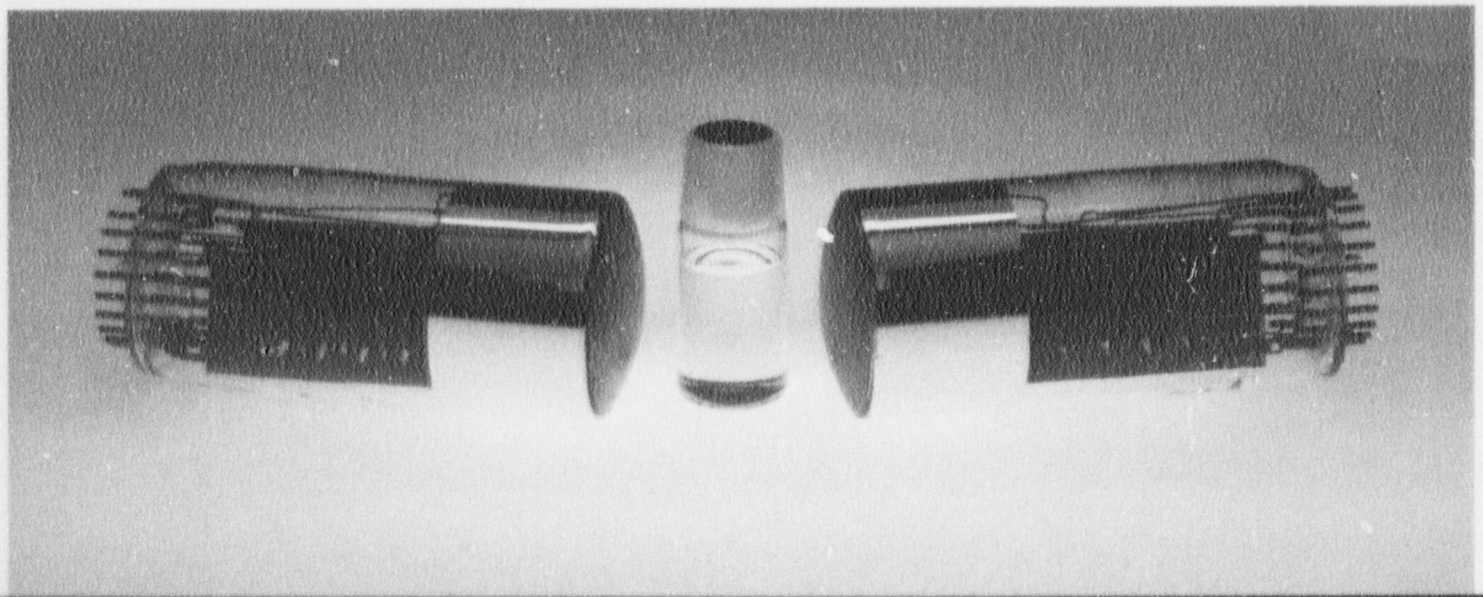
Accuracy throughout the life of the system is assured by Packard's exclusive automatic self-normalization and calibration. SNC is a special program designed to balance the individual response of each PMT, calibrate the SPECTRALYZER in energy units (keV) and retain the integrity of the SIS and SIE Quench Indicating Parameters (QIP).

Measuring efficiencies versus Spectral Index of Sample (SIS).



Dual label efficiency correlation curves where four equations are used to calculate DPM.

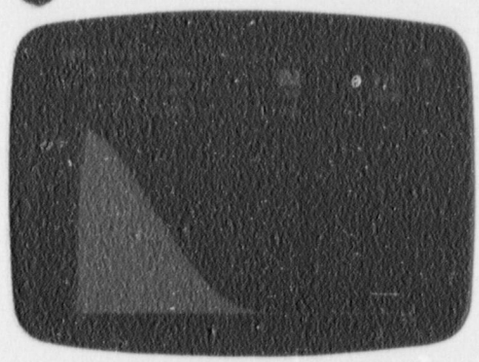




Special Features

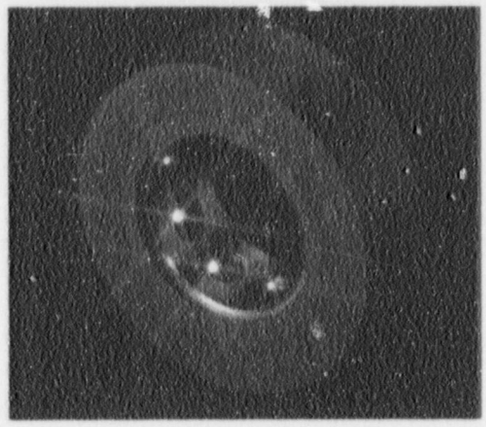
Spectraview

The Spectraview option allows display of the sample spectra on the video screen, observation of the effect of quenching, and visual determination of region limits. As region limits are adjusted, the updated digital display immediately shows the effect of the adjustment. The energy range is user-selectable to view any radionuclide and full scale CPM is autoranged to retain the spectral display on the video.



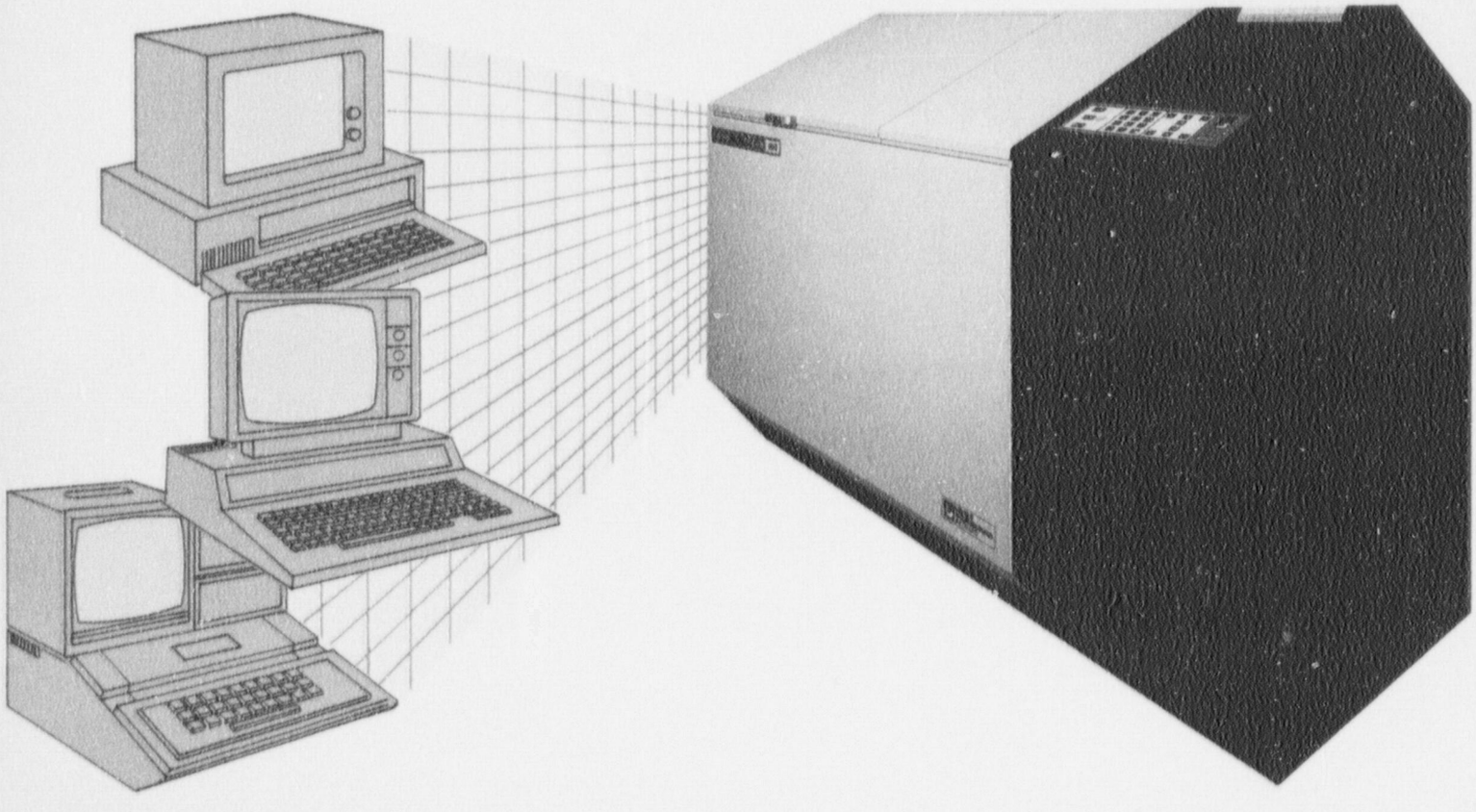
Electrostatic Controller

The optional Electrostatic Controller assures that your sample results are unaffected by spurious counts due to electrostatic discharge. In low humidity laboratories particularly where plastic counting vials are used, this nonradioactive electronic antistatic device neutralizes the static charge and gives you confidence in sample measurements.



RS232

The optional RS232 output is programmable and permits selected users to feed the counting data to any compatible peripheral device. Select TAPE-ON, TAPE-OFF to suppress any unwanted data.



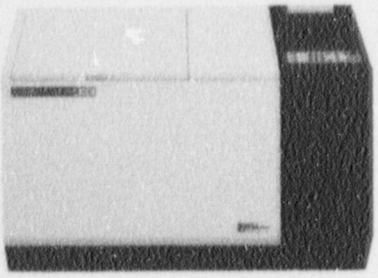
Specifications

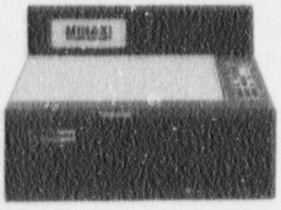
Counting Efficiency:	**4640/4660** **4530/4550** **4430/4450**	^{3}H > 60% ^{14}C > 95%

Dimensions:	**4640/4660**	**4530/4550**	**4430/4450**
	Width: 156 cm (62")	Width: 131 cm (52")	Width: 89 cm (35")
	Depth: 79 cm (31")	Depth: 79 cm (31")	Depth: 79 cm (31")
	Height: 114 cm (45½")	Height: 114 cm (45½")	Height: 63.5 (25")
	Weight: 385 kg (860 lbs)	Weight: 358 kg (800 lbs)	Weight: 269 kg (600 lbs)

Power Requirement:	117 Vac ± 10% or 234 Vac ±10% 50 or 60 Hz 400 Va (max) – Refrig. system 1100 Va.

Tri-Carb Features





	4430	4450	4530	4640	4550	4660
Sample Capacity	300	504	300	460	504	792
Sample Size	SM&LG	SM Vial	SM&LG	SM&LG	SM Vial	SM Vial
15 Count Programs (Protocols)	S	S	S	S	S	S
9" CRT Interactive Video Display	S	S	S	S	S	S
3 Regions	S	S	S	S	S	S
Self Normalization and Calibration	S	S	S	S	S	S
Bidirectional Cassette Changer	S	S	S	S	S	S
Simple Active Conversation	S	S	S	S	S	S
Multi-Microprocessor	S	S	S	S	S	S
Data Reduction	S	S	S	S	S	S
Spectralyzer	S	S	S	S	S	S
Touch Pad Control	S	S	S	S	S	S
Service Diagnostics	S	S	S	S	S	S
Auto Background Subtract	S	S	S	S	S	S
72 Hour Memory Protection	S	S	S	S	S	S
Automatic Restart	S	S	S	S	S	S
8 Preset Regions	S	S	S	S	S	S
3 User Adj. Regions	S	S	S	S	S	S
Low CPM Reject	S	S	S	S	S	S
6 Sec. Display Update	S	S	S	S	S	S
High Performance PMTs	S	S	S	S	S	S
SIS, SIE, AEC	O*	O*	S	S	S	S
^{226}Ra External Standard	O	O	S	S	S	S
PrioSTAT	O	O	O	O	O	O
80 Column Printer	O	O	O	O	O	O
Multi-User, 7 or 15	O	O	O	O	O	O
Time & Date Clock	O	O	O	O	O	O
Spectraview†	O	O	O	O	O	O
Histogram/Integration	O	O	O	O	O	O
Luminescence Detection and Correction (Selectable)†	O	O	O	O	O	O
RS232 (Selectable)	O	O	O	O	O	O
Temperature Control	NA	NA	O	O	O	O
DPM Dual & Single Label	O	O	O	O	O	O
Paper Tape Output	O	O	O	O	O	O
Electrostatic Controller	O	O	O	O	O	O

S - Standard, O - Optional, NA - Not Available, SM - Small Vial, LG - Large Vial
* - Requires external standard option for SIE analysis.
† - Requires PrioSTAT option.

Packard Picocare Service Support

At Packard, service is an integral part of a high technology product. Packard's professional, direct service organization stands ready to provide you prompt, courteous, and efficient service. Affordable service agreements are available on all Packard systems.

Specifications subject to change without notice. Specifications confirmed when Packard reference methods are applied.

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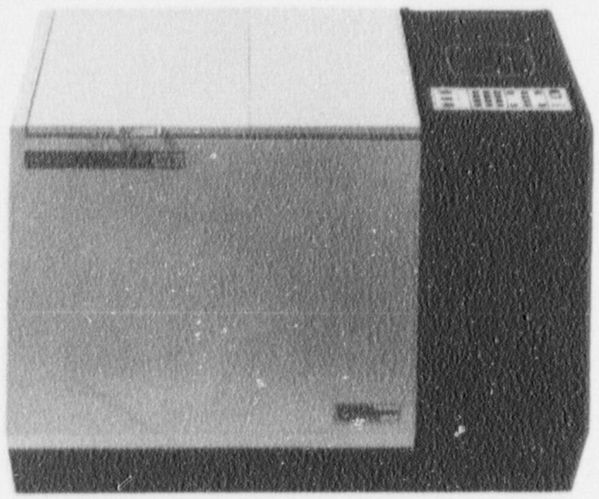
4000/LSC/384/A

TRI-CARB® 4000 SERIES

PROGRAMMABLE LIQUID SCINTILLATION SYSTEMS
MODELS 4530, 4550, 4640, & 4660

SPECIFICATIONS



Ordering Specifications

The TRI-CARB 4000 Automatic Liquid Scintillation Systems include the following standard features and specifications.

- Microprocessor controlled, cassette loaded, belt driven sample changer with forward and reverse controls. Sample changer also has anti-jam features on all functions. Sample capacities are as follows:

  Model 4530 - 300 samples, 10 samples per cassette, small or large vials.

  Model 4550 - 504 samples, 12 samples per cassette, small vials.

  Model 4640 - 460 samples, 10 samples per cassette, small or large vials.

  Model 4660 - 792 samples, 12 samples per cassette, small vials.

- SPECTRALYZER™ linear memory storage to accumulate all sample information during a measurement, 3 regions of interest to extract required data. Regions preset for ^{3}H, ^{14}C, ^{125}I and ^{32}P in single label, or $^{3}H/^{14}C$ and $^{3}H/^{32}P$ in dual label counting, or manually set in keV.

- System capacity, 15 independent sample measuring protocols. Also incorporates cycle control, 1-6 or infinite.

- Video Display and sensor control panel for conversation and displaying program contents - features editing, defining and deletion of programs. Normal display indicates sample number, time of counting, counts per minute (cpm) and 2 sigma % precision in each region, date and time.

- Count termination by time or 2 sigma % - 2 sigma % as preset count coincidence in all regions or individually set for each region.

- Measurement efficiency determined at all levels of quenching by unique spectral analysis method-independent of scintillation solution. Analysis of spectrum produces Spectral Index of Sample (SIS).

- ^{226}Ra external standard souce to measure efficiency - featuring spectral analysis of ^{226}Ra spectrum. Analysis of spectrum produces Spectral Index of External Standard (SIE).

- Automatic Efficiency Control (AEC) - to ensure the region settings are automatically compensated for quenching - applies to both the preset and the user determined regions. AEC is based on SIE.

- Automatic normalization of system - a precise method of automatically balancing the photomultiplier tubes (PMT's) and also calibrating the SPECTRALYZER.

- Automatic Data Reduction - programs include the following:

  - Date and time
  - floating decimal point readout
  - averaging of repeat sample counts
  - replicate sample counts and averaging
  - % of standard
  - background subtraction
  - low count rate rejection
  - normalizing factor

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- Automatic Efficiency Control (AEC) - to ensure the regions are automatically compensated for quenching - applies to both the preset and the user determined regions. AEC is based on SIE.

- A PrioSTAT™ manual sample changer, - a method to manually interrupt the automatic operation to determine the activity of specific sample(s) without affecting read-out. Used also to determine region limits and "identify" radionuclides.

- RS 232 compatible output, selectable through program conversation, includes tape-on control and tape leader between batches (program runs).

- Luminescence Detection and Correction, spectrally strips non-radioactive events from results - correction noted and precision printed.

- Histogram/Integration - provides a graphical representation of the counts or dpm of a sample batch above a user set threshold. Integration of cpm or dpm of a sample batch. Both programs operate in single and dual label.

- SPECTRAVIEW™ - sample spectrum displayed on video screen, offers visual spectrum search and quantitation. Region limits displayed for reference.

- Multi-user - 7 or 15 program selectors for multi-user sample changer operation.

- Electrostatic Controller - neutralizes static charges which can develop in low humidity laboratories.

- Printer - 80 column printer to provide hard copy output of all analysis.

Detailed Specifications and Descriptions

SAMPLE CHANGER

Cassettes, each with a capacity for 10 or 12 samples, (depending on system), are transported around the bi-directional sample changer by belt drive. The cassettes can accommodate Program Selectors with Cycle Control. A cassette with a Program Selector activates the measuring program for a batch of samples.

The Tri-Carb 4430 accommodates up to 30 cassettes giving a total sample capacity of 300. The Tri-Carb 4450 accommodates up to 42 cassettes giving a total sample capacity of 504. All positions are available for measuring samples.

Unoccupied positions in a cassette are automatically passed.

Cassettes loaded into the sample changer as a group remain grouped unless manually moved.

Activating the optional PrioSTAT moves a cassette out of the load position. The interruption of automatic operation permits the use of the manual sample changer. Automatic return to the interrupted sample occurs without disturbing the readout at the completion of PrioSTAT counting.

All sample changer motions are sequence controlled by the microprocessor. Sensors prevent malfunction and eliminate lock-up or jamming.

SPECTRALYZER

1. All detected events from the sample which satisfy the coincidence requirements are digitized and stored in the SPECTRALYZER during the measurement of the sample. This accumulation of counts continues until the measurement is terminated by time or by reaching the desired statistical precision.

2. Three regions of interest are provided to extract the required data from the SPECTRALYZER. For convenience the regions are automatically preset for ^{3}H, ^{14}C, ^{125}I and ^{32}P for single label measurements or $^{3}H/^{14}C$ and $^{3}H/^{32}P$ for dual label counting. In addition settings can be empirically determined or set according to the energy of the radionuclide(s) in the manual mode.

3. The entire sample spectrum is stored in memory. In the automatic operational mode the cpm in each region is displayed on the screen and printed at the end of the measurement. During a sample measurement, adjustments can be made to the region limits to optimize counting conditions. Changes do not alter the accumulated data in memory but the effect of the change is shown on the screen.

4. At the termination of sample counting, the stored spectrum is mathematically analyzed to provide a means of determining the measured efficiency. The analysis produces the Spectral Index of the Sample (SIS), a number unique to the level of quenching.

5. An optional external standard (^{226}Ra) may be incorporated into the system. The spectral distribution of this optional source is analyzed to produce the Spectral Index of the External Standard (SIE) to determine the quenching in the sample solution. The SIE is based on the net external standard spectrum, ie. following the subtraction of the sample spectrum.

6. The SIE is preset to 1000 with an unquenched sample. A decrease in SIE indicates quenching and thus a shift in the sample spectrum. Automatic Efficiency Control calculates the location of the stored spectra from the equivalent keV settings entered in the protocol, thus compensating for quenching.

3. The results of previous sample measurements, up to a maximum of nine. The measured data for each sample is presented on one line. Optional PrioSTAT measurements will also be displayed for a period of 30 minutes following the last "stat" measurement.

The display is also used for conversation with the system. Entering conversation displays a collection of related questions and answers. During conversation the system continues to measure samples, and displays the cpm (or dpm) of the measurement in progress.

CONVERSATION

To measure samples under a previously defined protocol it is not necessary to enter into the conversation mode. To define or edit a measurement protocol, conversation with the system is through the control panel sensor keys and the questions and responses displayed on the video. The complete contents of a counting protocol are displayed to simplify editing. Cursor controls on the keyboard allow the operator to enter a response to any question of the protocol in any order; unanswered questions are assigned values by the system. Protocols can be defined, edited, listed, copied and deleted. An audible signal signifies the entry of information.

A mode of conversation can be entered to adjust the region values during the measurement of a sample. As the display includes the cpm in each region, the effect of any adjustment becomes immediately apparent. In the dpm mode, a change in the radionuclide preset or in the region settings will invalidate the efficiency correlation and will thus inhibit dpm computations for the remaining samples of the batch. A readout of the modified protocol precedes any future measurements.

DATA REDUCTION AND READOUT

The data writer, optional with the system, provides a listing of the program parameters at the commencement of a program and prints column headings for the measured data. Following 60 lines of print the paper is advanced approximately 2.5 cm (1") and column headings are printed for additional sample data. A space of aproximately 2.5 cm (1") separates the readout of different program runs. A single space (line) separates the data from each cassette.

The column data includes Program #, Sample #, time of measurement, cpm/K and % deviation in each of the three measuring regions, SIS and/or SIE and elapsed time since program start. Additional data will be printed depending upon the information requested in the program.

Options (Can be field-installed)

- DPM for single and dual label samples, including plotting of efficiency correlation curves, replotting capabilities, editing and manual entry of data points.
- LUMINESCENCE DETECTION AND CORRECTION to monitor the presence of chemiluminescence contribution to the sample measurement and to correct the results accordingly.
- MULTI-USER - provides 7 or 15 program selectors for the sample changer.
- SPECTRAVIEW - the display of PrioSTAT sample spectra on the video screen allows regions limits to be visually determined. User selected resolution, counts per minute full scale adjustable or auto-range to obtain better definition.
- PRINTER - 80 column printer to provide hard copy of all analysis data on 8½" (21.7 cm) paper.
- INTEGRATION AND HISTOGRAM - selectable in the program. The cpm or dpm of a batch of samples is summed above a user adjustable threshold value. Integration applies to single and dual labelled samples. A histogram is plotted at the end of a sample batch with an ordinate of cpm or dpm. The ordinate is program selected or is auto-ranged to plot all points on scale. Histogram capacity 100 samples in single label.
- TEMPERATURE CONTROL - a refrigeration system to maintain a constant temperature environment for measuring samples.
- RS 232 COMPATABLE INTERFACE - output to a computer interface, selectable through program conversation when defining measuring parameters. Includes tape on control and tape leader between batches (program runs).
- ELECTROSTATIC CONTROLLER - a non-radioactive anti-static charge device to eliminate spurious counts from plastic vials in laboratories with low humidity.
- A PrioSTAT - manual sample changer, - a method to manually interrupt the automatic operation to determine the activity of sample(s) without affecting read-out. Used also to determine region limits and "identify" radionuclides.

Physical Data

- Dimensions:

	4530/4550	4640/4660
Height	114 cm (45½")	114 cm (45½")
Width	131 cm (52")	156 cm (62")
Depth	79 cm (31")	79 cm (31")
Weight	358 kg (800 lbs)	385 kg (860 lbs)

- Power Requirements
  117 Vac ± 10% or 234 Vac ± 10%
  50 or 60 Hz 400 VA (max.)
  Cooling system - 1100 VA.

Specifications are subject to change without notice.

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SS4000/LSC/484

7. Live time control with crystal controlled time prevents pulse pile up and loss of counts at high count rates. Maximum count rate is approximately 4 x 10^6 counts per minute.

8. Sample counting is terminated automatically by the time entered in the program or, by a count precision (2 sigma %). Precision is entered for each region and the count continued until the desired precision is achieved in each region. Time settings are from 0.10 minutes, with intervals of 0.01 minutes to a maximum of 999.99 minutes. Precision 2 sigma % is from 0.10 to 10.0%.

AUTOMATIC EXTERNAL STANDARD

1. The optional radioactive source used in the system is radium-226, doubly encapsulated.

2. The radioactive source moves from its OUT position through tubing to a precisely fixed IN position in the detector chamber. The source is driven by a pneumatic pump. Maximum position accuracy of the source is assured.

3. The OUT position of the source is shielded by lead to prevent increase in background of the sample count. The radiation from the standard in the IN and OUT position is below the internationally accepted tolerance level.

4. The optional External Standard, if selected, is automatically positioned for fifteen seconds prior to sample measurement to store the spectrum. During the first fifteen seconds of sample count time any sample contribution is subtracted prior to analysis of the spectrum. The Spectral Index of the External Standard (SIE) measures the quenching in the scintillation vial, and therefore, the location of the spectral shift of the sample counts. SIE thus directs AEC to extract the appropriate data from the SPECTRALYZER.

5. The dynamic range of efficiency correlation is effectively over 100:1 and, therefore, suitable for any radionuclide and any quenching value. The Spectral Index for the External Standard (SIE) is established at 1000 for an unquenched standard. The SIE decreases with increasing quenching.

AUTOMATIC NORMALIZATION AND CALIBRATION

An unquenched ^{14}C standard is provided with the instrument, and used to normalize the system.

Normalization and calibration is automatic. Normalization individually adjusts each PMT to balance the response to radioactivity, it also calibrates the SPECTRALYZER in keV. Calibration, in addition, preserves the integrity of the efficiency correlation(s) established by the system by re-establishing the SIS and an SIE of 1000.

SYSTEM CONTROL

Microprocessors control all instrument functions. The sample changer advances until a Program Selector is sensed, at which time all parameters are determined for the measurement of the sample batch.

A System Control Panel is provided to manually operate the instrument, inadvertent operation is avoided by an ENABLE key. The key pad is used to define, display, and edit a measuring program. During sample measurements the SPECTRALYZER stores and analyzes the detected events from the sample and computes the data requested by the user. Fifteen programs can be defined and stored. Programs can be copied from one to another.

A Cycle Control (selectable for 1-6 cycles) on the Program Selector is decremented each time the batch of samples is measured until no further cycles are required. The number of times the sample batch is recycled for measurement can also be set to infinity. An inspection of the Sample Changer indicates the number of cycles remaining.

An optional priority interrupt function transfers system control to a separate optional, manually operated sample changer. The PrioSTAT control automatically loads a sample and initiates the measurement. The video display allows the investigator to observe the sample counts. In addition the sample counting parameters can be changed during the measurement to determine the region limits. The procedure will determine the required radionuclide settings for any sample independent of its quench level. By reverse AEC the system automatically computes the unquenched region limits for entering into a program or for identifying the radionuclide. At the completion of the PrioSTAT mode the instrument automatically returns to the interrupted program to continue normal automatic operation.

VIDEO DISPLAY

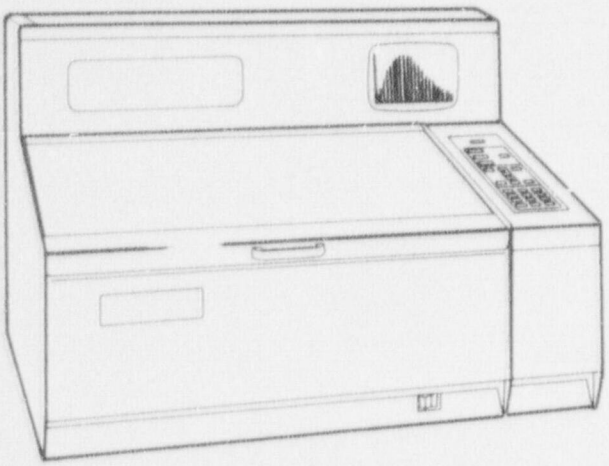
A 9" (diagonal measurement) video display with anti-reflection surface is mounted on the panel of the cabinet. During the measurement of samples the display indicates:

1. The sample number being measured and the count time.
2. The cpm and 2 sigma % values in each measuring region, which are updated every 6 seconds. (In dpm mode the estimated dpm is displayed instead of cpm).
3. The results of previous sample measurements, up to a maximum of nine. The measured data for each sample is presented on one line. The optional PrioSTAT measurements will also be displayed for a period of 30 minutes following the last "stat" measurement.

TRI-CARB® 4400 SERIES

PROGRAMMABLE LIQUID SCINTILLATION TABLE TOP SYSTEMS
MODELS 4430 & 4450

SPECIFICATIONS



Ordering Specifications

The TRI-CARB 4400 Series Automatic Liquid Scintillation Table Top Systems include the following standard features and specifications.

- 4430 - microprocessor controlled, cassette loaded, belt driven sample changer with forward and reverse controls, 300 conventional vial sample capacity, 10 samples per cassette. Sample changer also has anti-jam features on all functions.

- 4450 - microprocessor controlled, cassette loaded, belt driven sample changer with forward and reverse controls, 504 small-vial sample capacity, 12 samples per cassette. Sample changer also has anti-jam features on all functions.

- SPECTRALYZER™ linear memory storage to accumulate all sample information during a measurement, 3 regions of interest to extract required data. Regions preset for ^{3}H, ^{14}C, ^{125}I and ^{32}P in single label, or $^{3}H/^{14}C$ and $^{3}H/^{32}P$ in dual label counting or manually set in keV.

- System capacity, 15 independent sample measuring protocols. Also incorporates cycle control, 1-6 or infinite.

- Amber screen video display and sensor control panel for conversation and displaying protocol contents — features editing, defining and deletion of protocols. Normal display indicates sample number, program number, time of counting, counts per minute (cpm) and 2 sigma % precision in each region, date and time.

- Count termination by time or 2 sigma % - 2 sigma % as preset count individually set for each region.

- Measurement efficiency determined at all levels of quenching by unique spectral analysis method-independent of scintillation solution. Analysis of spectrum produces Spectral Index of Sample (SIS).

- Automatic normalization of system - a precise method of automatically balancing the photomultiplier tubes (PMT's) and also calibrating the SPECTRALYZER.

- Automatic Data Reduction - programs include the following:

  - Date and time
  - floating decimal point readout
  - averaging of repeat sample counts
  - replicate sample counts and averaging
  - % of standard
  - background subtraction
  - low count rate rejection
  - normalizing factor

Options for the TRI-CARB 4400 Series

- DPM for single labelled samples based on spectral analysis of sample events, DPM of single and dual labelled samples based on optional external standard spectral analysis - efficiency correlation plotted, and replotted on request.

- ^{226}Ra external standard source to measure efficiency - featuring spectral analysis of ^{226}Ra spectrum. Analysis of spectrum produces Spectral Index of External Standard (SIE).

- Automatic Efficiency Control (AEC) - to ensure the regions are automatically compensated for quenching - applies to both the preset and the user determined regions. AEC is based on SIE.

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- A PrioSTAT™ manual sample changer, - a method to manually interrupt the automatic operation to determine the activity of specific sample(s) without affecting read-out. Used also to determine region limits and "identify" radionuclides.
- RS 232 compatible output, output format selectable, includes tape-on control and tape leader between batches (program runs), 1200 baud.
- Luminescence Detection and Correction, spectrally strips non-radioactive events from results - correction noted and precision printed.
- Histogram/Integration - provides a graphical representation of the counts or dpm of a sample batch above a user set threshold. Integration of cpm or dpm of a sample batch. Both programs operate in single and dual label.
- SPECTRAVIEW™ - sample spectrum displayed on video screen, offers visual spectrum search and quantitation. Region limits displayed for reference.
- Spectrumplot for hardcopy reference.
- Multi-user - 7 or 15 program selectors for multi-user sample changer operation.
- Electrostatic Controller - neutralizes static charges which can develop in low humidity laboratories.
- PC-DAAS™-on-line data reduction with IBM-PC, RIA calculations, steroid receptor analysis, data acquisition and storage.
- Printer - 80 column printer to provide hard copy output of all analysis. Data transmission: 120 characters per second.

Detailed Specifications and Descriptions

SAMPLE CHANGER

Cassettes, each with a capacity for 10 or 12 samples, (depending on system), are transported around the bi-directional sample changer by belt drive. The cassettes can accommodate Program Selectors with Cycle Control. A cassette with a Program Selector activates the measuring program for a batch of samples.

The Tri-Carb 4430 accommodates up to 30 cassettes giving a total sample capacity of 300. The Tri-Carb 4450 accommodates up to 42 cassettes giving a total sample capacity of 504. All positions are available for measuring samples.

Unoccupied positions in a cassette are automatically passed.

Cassettes loaded into the sample changer as a group remain grouped unless manually moved.

Activating the optional PrioSTAT moves a cassette out of the load position. The interruption of automatic operation permits the use of the manual sample changer. Automatic return to the interrupted sample occurs without disturbing the readout at the completion of PrioSTAT counting.

All sample changer motions are sequence controlled by the microprocessor. Sensors prevent malfunction and eliminate lock-up or jamming.

SPECTRALYZER

1. All detected events from the sample which satisfy the coincidence requirements are digitized and stored in the SPECTRALYZER during the measurement of the sample. This accumulation of counts continues until the measurement is terminated by time or by reaching the desired statistical precision.

2. Three regions of interest are provided to extract the required data from the SPECTRALYZER. For convenience the regions are automatically preset for ^{3}H, ^{14}C, ^{125}I and ^{32}P for single label measurements or $^{3}H/^{14}C$ and $^{3}H/^{32}P$ for dual label counting. In addition settings can be empirically determined or set according to the energy of the radionuclide(s) in the manual mode.

3. The entire sample spectrum is stored in memory. In the automatic operational mode the cpm in each region is displayed on the screen and printed by the built-in printer at the end of the measurement. During a sample measurement, adjustments can be made to the region limits to optimize counting conditions. Changes do not alter the accumulated data in memory but the effect of the change is shown on the screen.

4. At the termination of sample counting, the stored spectrum is mathematically analyzed to provide a means of determining the measured efficiency. The analysis produces the Spectral Index of the Sample (SIS), a number unique to the level of quenching.

5. An optional external standard (^{226}Ra) may be incorporated into the system. The spectral distribution of this optional source is analyzed to produce the Spectral Index of the External Standard (SIE) to determine the quenching in the sample solution. The SIE is based on the net external standard spectrum, ie. following the subtraction of the sample spectrum.

6. The SIE is preset to 1000 with an unquenched sample. A change in SIE indicates quenching and thus a shift in the sample spectrum. Automatic Efficiency Control calculates the location of the stored spectra from the equivalent keV settings entered in the protocol, thus compensating for quenching.

CONVERSATION

To measure samples under a previously defined protocol it is not necessary to enter into the conversation mode. To define or edit a measurement protocol, conversation with the system is through the control panel sensor keys and the questions and responses displayed on the video. The complete contents of a counting protocol are displayed to simplify editing. Cursor controls on the keyboard allow the operator to enter a response to any question of the protocol in any order; unanswered questions are assigned values by the system. Protocol can be defined, edited, listed, copied and deleted. An audible signal signifies the entry of information.

A mode of conversation can be entered to adjust the region values during the measurement of a sample. As the display includes the cpm in each region, the effect of any adjustment becomes immediately apparent. In the dpm mode, a change in the radionuclide preset or in the region settings will invalidate the efficiency correlation and will thus inhibit dpm computations for the remaining samples of the batch. A readout of the modified protocol precedes any future measurements.

DATA REDUCTION AND READOUT

The optional data writer provides a listing of the program parameters at the commencement of a program and prints column headings for the measured data. Following 60 lines of print the paper is advanced approximately 2.5 cm (1") and column headings are printed for additional sample data. A space of aproximately 2.5 cm (1") separates the readout of different program runs. A single space (line) separates the data from each cassette.

The column data includes Program #, Sample #, time of measurement, cpm/K and % deviation in each of the three measuring regions, SIS and/or SIE and elapsed time since program start. Additional data will be printed depending upon the information requested in the program.

Options (Can be field-installed)

- DPM for single and dual label samples, including plotting of efficiency correlation curves, replotting capabilities, editing and manual entry of data points.
- LUMINESCENCE DETECTION AND CORRECTION to monitor the presence of chemiluminescence contribution to the sample measurement and to correct the results accordingly.
- SPECTRAVIEW - the display of PrioSTAT sample spectra on the video screen allows regions limits to be visually determined. User selected resolution, counts per minute full scale adjustable or auto-range to obtain better definition.
- SPECTRUM PLOT - the PrioSTAT sample spectrum can be printed for hardcopy documentation.
- INTEGRATION AND HISTOGRAM - selectable in the program. The cpm or dpm of a batch of samples is summed above a user adjustable threshold value. Integration applies to single and dual labelled samples. A histogram is plotted at the end of a sample batch with an ordinate of cpm or dpm. The ordinate is program selected or is auto-ranged to plot all points on scale. Histogram capacity 100 samples in single label.
- MULTI-USER - provides 7 or 15 program selectors for the sample changer.
- PrioSTAT - manually operated sample changer for a single "STAT" sample.
- ^{226}Ra external standard source to measure efficiency - featuring spectral analysis of ^{226}Ra spectrum. Analysis of spectrum produces Spectral Index of External Standard (SIE).
- RS 232 COMPATABLE INTERFACE - output to a computer interface, selectable through program conversation when defining measuring parameters. Includes tape on control and tape leader between batches (program runs), 300, 600 or 1200 baud.
- PRINTER - 80 column printer to provide hard copy of all analysis data on 8½" (21.7 cm) paper.
- ELECTROSTATIC CONTROLLER - a non-radioactive anti-static charge device to eliminate spurious counts from plastic vials in laboratories with low humidity.
- RIA/QC* - comprehensive data management for radioassay counting. RIA calculations based on 4PL, smoothed spline and mass action low equations. Corrections for variable NSB, multiple dilution factors, radionuclide half-life. On- and off-line calculations. Storage of sample data for recalculations. Real-time and long-term quality control, based on Stewart/Levey-Jennings and Cusum plots.
- STEROID RECEPTOR ANALYSIS* - for single- or dual-label estrogen/progestron receptor assays. Scatchard plot and saturation curve calculations with curve editing. Rosenthal correction for NSB. On- and off-line processing with data storage.

*Requires PC-DAAS (on-line IBM-PC computer)

Physical Data

- Dimensions:

Height	63.5	cm	(25")
Width	89	cm	(35")
Depth	79	cm	(31")
Weight	270	kg	(600 lb)

- Power Requirements

  117 Vac ± 10% or 234 Vac ± 10%
  50 or 60 Hz 400 VA (max.)

7. Live time control with crystal controlled time prevents pulse pile up and loss of counts at high count rates. Maximum count rate is approximately 4 x 10^6 counts per minute.

8. Sample counting is terminated automatically by the time entered in the program or, by a count precision (2 sigma %). Precision is entered for each region and the count continued until the desired precision is achieved in each region. Time settings are from 0.10 minutes, with intervals of 0.01 minutes to a maximum of 999.99 minutes. Precision 2 sigma % is from 0.10 to 10.0%.

AUTOMATIC EXTERNAL STANDARD

1. The optional radioactive source used in the system is radium-226, doubly encapsulated.

2. The radioactive source moves from its OUT position through tubing to a precisely fixed IN position in the detector chamber. The source is driven by a pneumatic pump. Maximum position accuracy of the source is assured.

3. The OUT position of the source is shielded by lead to prevent increase in background of the sample count. The radiation from the standard in the IN and OUT position is below the internationally accepted tolerance level.

4. The External Standard, if selected, is automatically positioned for fifteen seconds prior to sample measurement to store the spectrum. During the first fifteen seconds of sample count time, any sample contribution is subtracted prior to analysis of the spectrum. The Spectral Index of the External Standard (SIE) measures the quenching in the scintillation vial, and therefore, the location of the spectral shift of the sample counts. SIE thus directs AEC to extract the appropriate data from the SPECTRALYZER.

5. The dynamic range of efficiency correlation is effectively over 100:1 and, therefore, suitable for any radionuclide and any quenching value. The Spectral Index for the External Standard (SIE) is established at 1000 for an unquenched standard. The SIE decreases with increasing quenching.

AUTOMATIC NORMALIZATION AND CALIBRATION

An unquenched ^{14}C standard is provided with the instrument, and used to normalize the system.

Normalization and calibration is automatic. Normalization individually adjusts each PMT to balance the response to radioactivity, it also calibrates the SPECTRALYZER in keV. Calibration, in addition, preserves the integrity of the efficiency correlation(s) established by the system by re-establishing the SIS and an SIE of 1000.

SYSTEM CONTROL

Microprocessors control all instrument functions. The sample changer advances until a Program Selector is sensed, at which time all parameters are determined for the measurement of the sample batch.

A System Control Panel is provided to manually operate the instrument, inadvertent operation is avoided by an ENABLE key. The key pad is used to define, display, and edit a measuring protocol. During sample measurements the SPECTRALYZER stores and analyzes the detected events from the sample and computes the data requested by the user. Fifteen protocols can be defined and stored. Protocols can be copied from one to another.

A Cycle Control (selectable for 1-6 cycles) on the Program Selector is decremented each time the batch of samples is measured until no further cycles are required. The number of times the sample batch is recycled for measurement can also be set to infinity. An inspection of the Sample Changer indicates the number of cycles remaining.

An optional priority interrupt function transfers system control to a separate optional, manually operated sample changer. The PrioSTAT control automatically loads a sample and initiates the measurement. The video display allows the investigator to observe the sample counts. In addition the sample counting parameters can be changed during the measurement to determine the region limits. The procedure will determine the required radionuclide settings for any sample independent of its quench level. By reverse AEC the system automatically computes the unquenched region limits for entering into a program or for identifying the radionuclide. At the completion of the PrioSTAT mode the instrument automatically returns to the interrupted program to continue normal automatic operation.

VIDEO DISPLAY

A 9" (diagonal measurement) amber screen video display with anti-reflection surface is mounted on the panel of the cabinet. During the measurement of samples the display indicates:

1. The sample number being measured, the program number and the count time.

2. The cpm and 2 sigma % values in each measuring region, which are updated every 6 seconds. (In dpm mode the estimated dpm is displayed instead of cpm).

3. The results of previous sample measurements, up to a maximum of nine. The measured data for each sample is presented on one line. The optional PrioSTAT measurements will also be displayed for a period of 30 minutes following the last "stat" measurement.

The display is also used for conversation with the system. Entering conversation displays a collection of related questions and answers. During conversation the system continues to measure samples, and displays the cpm (or dpm) of the measurement in progress.

Attached are the results of the wipes conducted at Centre Circle Drive building, a copy of the letter and information sent to Mr. Michael Ewan of the Illinois Department of Nuclear Safety (see attachment A) and the efficiency graphs for H-3 and C-14 for the two LSC units used for counting.

All wipes conducted covered 10,000 cm^2 instead of 100 cm^2, thus, the results of any contamination were well within regulatory limits. Those areas above 100 CPM were decontaminated with a product called Rad-Con™ by Nuclear Associates and rewiped to determine if most of the removable contamination was now eliminated.

The wipes, Whatman #40-5.5 cm filter paper, were placed in scintillation vials where 10 ml of Opti-Fluor™ scintillator was added and the vial was then shaken to thoroughly remove any contamination present on the wipe. The vials were then placed in Packard's LSC units for counting with the unit operating with the blank sample or background subtracted.

A review of the analysis of the wipes revealed only tritium elevations in four areas (see attachment B) which were still within limits. The counting efficiency was then determined for the two LSC units utilized (see attachment C) by spiking a clean, moderately dirty, and dirty filter paper with 100,000 DPM of C-14 and H-3. Thus, even under the worst condition, the 756 CPM converts to 54,000 DPM which averaged only 5.4 DPM/cm which is less than the regulatory limit of 10. The rewipes of those areas indicating an elevation resulted in a considerable decrease (see attachment D) with only one area needing further decontamination and rewiped.

Surveys were conducted with the portable radiation survey meters over the entire building with emphasis placed on cracks in the floor where a sealed source may have accidentally been lost. The results revealed no sources present and the only really noted elevation was from the cement block which was confirmed by wipes taken at A-14 to A-21, indicated on the grid map of the building.

JMS
12/19/85

CONTROL NO. 80385

P#		S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	%MIN
7	A	41	5.00	.00	24.0	4.80	21.3	.00	13.9	.000	31.297		%178
7		42	5.00	.00	20.7	2.60	22.7	1.80	13.1	.000	60.700		%183
7		43	5.00	.40	19.8	.00	27.2	.00	14.0	.000	14.000		%189
7		44	5.00	.00	20.5	.60	24.4	.00	13.8	.000	81.440		%194
7		45	5.00	.80	19.6	1.60	23.5	3.00	12.9	.000	0.000		%199
7		46	5.00	2.00	19.0	1.80	23.4	3.40	12.9	.000	0.000		%205
7		47	5.00	.00	22.5	.00	25.8	.00	14.9	.000	35.455		%210
7		48	5.00	7.20	17.1	2.40	22.9	10.80	12.0	.000	17.284		%215
7		49	5.00	.00	23.4	.00	26.0	.00	14.9	.000	20.552		%221
7	A	50	5.00	.00	22.2	.80	24.2	.00	14.4	.000	31.160		%226
7		51	5.00	.00	22.0	1.20	23.9	.00	14.3	.000	28.758		%232
7		52	5.00	.00	20.8	1.00	24.0	.00	13.4	.000	30.311		%237
7		53	5.00	.00	22.2	.00	26.4	.00	14.1	.000	26.360		%242
7		54	5.00	.60	19.7	2.80	22.6	.80	13.2	.000	18.400		%248
7		55	5.00	.00	21.9	.00	26.7	.00	14.1	.000	23.244		%253
7		56	5.00	.00	23.5	2.20	23.0	.00	14.2	.000	27.067		%259
7		57	5.00	.00	21.9	.80	24.2	.00	13.6	.000	39.244		%264
7		58	5.00	.00	21.3	.00	26.4	.00	14.0	.000	11.138		%269
7		59	5.00	.00	22.5	.00	25.0	.00	14.2	.000	18.000		%275
7	A	60	5.00	.00	20.7	2.60	22.7	.00	13.4	.000	33.100		%280
7		61	5.00	.00	21.6	1.60	23.5	1.00	13.2	.000	14.650		%286
7		62	5.00	.00	22.3	.60	24.4	.00	14.3	.000	40.419		%291
7		63	5.00	.00	21.2	.00	25.0	.00	14.0	.000	50.733		%296
7		64	5.00	.00	21.2	1.20	23.9	.00	13.8	.000	26.333		%302
7		65	5.00	1.60	19.2	1.00	24.0	3.00	12.9	.000	48.300		%307
7		66	5.00	.00	22.2	2.00	23.2	.00	13.9	.000	30.120		%313
7		67	5.00	.00	21.6	.60	24.4	.00	14.1	.000	49.050		%318
7		68	5.00	2.40	18.9	.80	24.2	1.20	13.2	.000	0.000		%323
7		69	5.00	.00	22.5	1.60	23.5	.00	13.8	.000	20.545		%329
7	A	70	5.00	.00	21.9	.00	26.4	.00	14.4	.000	27.956		%334
7		71	5.00	117.80	7.62	.40	24.6	119.60	6.98	.000	8.119		%340
7		72	5.00	.00	21.6	3.40	22.2	.00	13.4	.000	27.250		%345
7		73	5.00	.00	23.2	.00	26.0	.00	14.4	.000	21.229		%350
7		74	5.00	.00	20.2	.00	25.2	.00	13.5	.000	82.000		%356
7		75	5.00	.00	20.3	3.80	21.9	2.40	13.0	.000	192.26		%361
7		76	5.00	.00	20.0	1.00	24.0	.80	13.2	.000	0.000		%366
7		77	5.00	.00	22.3	2.00	23.2	.00	13.5	.000	23.124		%372
7		78	5.00	.00	21.0	1.00	24.0	.00	13.7	.000	86.327		%377
7		79	5.00	1.60	19.2	1.20	23.9	2.40	13.0	.000	2.300		%383
7	A	80	5.00	.00	20.5	3.00	22.5	1.00	13.2	.000	43.360		%388
7		81	5.00	.00	20.8	1.40	23.7	.00	13.8	.000	0.000		%393
7		82	5.00	.00	21.5	1.00	24.0	.00	13.7	.000	18.720		%399
7		83	5.00	.00	22.2	2.20	23.0	.00	13.7	.000	31.160		%404
7		84	5.00	.00	24.0	2.00	23.2	.00	14.2	.000	26.255		%410
7		85	5.00	.00	20.9	.00	25.4	.00	14.0	.000	36.880		%415
7		86	5.00	.00	21.8	.20	24.8	.00	13.5	.000	10.024		%420
7		87	5.00	.00	22.6	.00	26.9	.00	14.7	.000	34.567		%426
7		88	5.00	.00	22.7	2.40	22.9	.00	13.6	.000	35.104		%431
7		89	5.00	.00	20.8	.00	26.2	.00	14.0	.000	53.067		%436
7	A	90	5.00	.00	22.7	1.60	23.5	.00	14.4	.000	22.880		%442

ATTACHMENT B

PROGRAM #= 7 01/01/00 04:11

REGION A: LL-UL= 0- 19 LCR= 0 BKG= .00 % 2 SIGMA= .0

REGION B: LL-UL= 19- 156 LCR= 0 BKG= .00 % 2 SIGMA= .0

REGION C: LL-UL= 0-2000 LCR= 0 BKG= .00 % 2 SIGMA= .0

TIME= 5.00 K= 1.000 QIP=SIS

LUMINESCENCE CORRECTION OFF

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	%MIN
7	Blank	10.00	20.00	14.1	12.80	17.6	44.60	9.47	.000	23.253	B	% 10
	1	5.00	.00	22.7	.00	26.4	.00	14.5	.000	24.864		%857
	2	5.00	.00	22.0	3.80	21.9	.00	13.4	.000	23.621		%862
	3	5.00	.00	22.9	.40	24.6	.00	14.3	.000	35.292		%868
	4	5.00	.00	21.8	1.00	24.0	.00	13.5	.000	23.765		%873
	5	5.00	.00	23.7	1.60	23.5	.00	14.2	.000	33.161		%879
	6	5.00	.00	22.5	.00	25.0	.00	14.2	.000	35.309		%884
	7	5.00	.00	20.6	.00	26.0	.00	13.8	.000	0.000		%889
	8	5.00	.00	20.5	.20	24.8	.00	13.9	.000	100.00		%895
	9	5.00	.00	20.0	1.60	23.5	.00	13.8	.000	******		%900
	10	5.00	.00	20.3	.00	25.2	.00	13.7	.000	119.20		%906
7	A 11	5.00	.00	21.6	.00	25.6	.00	14.0	.000	38.050		% 16
7	12	5.00	2.00	19.0	.00	26.2	1.40	13.1	.000	0.000		% 22
7	13	5.00	1.20	19.4	2.00	23.2	2.60	13.0	.000	0.000		% 27
7	14	5.00	.00	21.4	1.00	24.0	.00	13.6	.000	59.829		% 32
7	15	5.00	.00	20.6	2.00	23.2	1.40	13.1	.000	58.000		% 38
7	16	5.00	.00	20.7	.00	25.0	.00	13.5	.000	55.500		% 43
7	17	5.00	.00	20.6	2.20	23.0	.00	13.8	.000	53.143		% 48
7	18	5.00	1.20	19.4	3.20	22.3	6.80	12.4	.000	0.000		% 54
7	19	5.00	.00	21.3	.80	24.2	.00	14.0	.000	35.385		% 59
7	A 20	5.00	.00	21.5	.00	27.2	.00	14.3	.000	38.347		% 65
7	21	5.00	.00	20.5	.00	26.0	.00	14.2	.000	118.56		% 70
7	22	5.00	4.20	18.1	.00	25.4	2.40	13.0	.000	0.000		% 75
7	23	5.00	.80	19.6	.00	27.7	.80	13.2	.000	0.000		% 81
7	24	5.00	2.00	19.0	3.60	22.0	6.60	12.5	.000	0.000		% 86
7	25	5.00	.00	21.8	.40	24.6	.00	13.9	.000	41.835		% 92
7	26	5.00	.00	21.4	2.80	22.6	.00	13.3	.000	31.029		% 97
7	27	5.00	.00	21.8	.00	27.2	.00	14.4	.000	49.929		%102
7	28	5.00	.00	22.5	.80	24.2	.00	14.2	.000	37.491		%108
7	29	5.00	.00	21.6	1.00	24.0	.00	14.1	.000	22.750		%113
7	A 30	5.00	.40	19.8	.00	27.7	.00	13.7	.000	0.000		%118
7	31	5.00	.00	21.3	1.00	24.0	.00	13.6	.000	57.046		%124
7	32	5.00	.00	21.5	4.00	21.8	.00	13.5	.000	30.987		%129
7	33	5.00	.00	20.7	.00	27.4	.00	13.9	.000	17.500		%135
7	34	5.00	.00	21.3	1.80	23.4	.80	13.2	.000	34.400		%140
7	35	5.00	1.40	19.3	1.00	24.0	1.40	13.1	.000	0.000		%145
7	36	5.00	.00	21.4	.00	27.2	.00	14.1	.000	61.314		%151
7	37	5.00	.00	20.2	1.40	23.7	.00	13.4	.000	215.59		%156
7	38	5.00	.00	20.6	.00	25.8	.00	13.7	.000	86.514		%162
7	A 39	5.00	.00	21.9	.00	27.4	.00	13.7	.000	41.556		%167
7	A 40	5.00	2.00	19.0	.00	25.2	3.00	12.9	.000	0.000		%172

#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	%MIN
A	91	5.00	.00	20.7	.40	24.6	.00	13.7	.000	7.100		%447
	92	5.00	.00	20.9	.00	25.2	.00	13.8	.000	40.400		%453
	93	5.00	.00	23.2	.80	24.2	.00	13.8	.000	29.057		%458
	94	5.00	.00	20.5	.40	24.6	.00	13.4	.000	56.160		%463
	95	5.00	.00	22.5	.00	25.6	.00	14.5	.000	26.330		%469
	96	5.00	.00	20.6	3.00	22.5	1.80	13.1	.000	34.857		%474
	97	5.00	.00	22.0	1.40	23.7	.00	13.5	.000	28.337		%480
	98	5.00	.00	20.1	.00	25.0	.00	13.3	.000	165.59		%485
	99	5.00	.00	22.3	2.00	23.2	.00	13.8	.000	36.000		%490
A	100	5.00	.00	20.6	.60	24.4	.00	13.7	.000	61.829		%496
	101	5.00	5.00	17.8	5.40	20.9	10.40	12.0	.000	17.200		%501
	102	5.00	.00	21.9	.00	25.2	.00	14.4	.000	15.689		%507
	103	5.00	.00	22.0	.00	25.4	.00	14.0	.000	30.947		%512
	104	5.00	2.00	19.0	1.60	23.5	1.20	13.2	.000	21.520		%517
#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	%MIN
	105	5.00	.00	22.3	1.00	24.0	.00	13.9	.000	30.514		%523
	106	5.00	.00	21.5	.00	26.9	.00	14.7	.000	49.760		%528
	107	5.00	2.80	18.7	.00	25.6	3.40	12.9	.000	32.800		%534
	108	5.00	.00	21.8	.60	24.4	.00	14.0	.000	39.671		%539
	109	5.00	1.00	19.5	3.60	22.0	7.00	12.4	.000	58.720		%544
A	110	5.00	.00	21.2	.00	25.8	.00	14.0	.000	43.667		%550
	111	5.00	.00	20.3	.60	24.4	.00	13.5	.000	76.533		%555
	112	5.00	.80	19.6	1.00	24.0	1.20	13.2	.000	0.000		%561
	113	5.00	.00	20.8	.80	24.2	.00	13.4	.000	43.644		%566
	114	5.00	.20	19.9	2.20	23.0	2.40	13.0	.000	172.00		%571
	115	5.00	.00	20.6	.00	25.4	.00	13.8	.000	33.714		%577
	116	5.00	.00	21.0	3.20	22.3	.00	13.4	.000	6.036		%582
	117	5.00	.00	21.9	.00	26.2	.00	14.0	.000	38.622		%587
	118	5.00	.00	20.8	1.80	23.4	.00	13.4	.000	24.444		%593
	119	5.00	.00	20.8	.80	24.2	.00	13.6	.000	63.556		%598
A	120	5.00	.00	22.5	.00	25.8	.00	14.6	.000	31.600		%604
	121	5.00	2.00	19.0	.00	25.4	2.40	13.0	.000	10.480		%609
	122	5.00	.00	20.6	3.40	22.2	1.60	13.1	.000	30.533		%614
	123	5.00	.00	20.9	2.00	23.2	.00	13.6	.000	12.880		%620
	124	5.00	.00	22.0	1.40	23.7	.00	13.9	.000	46.611		%625
	125	5.00	.00	22.5	.20	24.8	.00	14.2	.000	34.436		%631
	126	5.00	.00	20.5	1.80	23.4	1.40	13.1	.000	61.920		%636
	127	5.00	.00	23.5	4.40	21.5	.00	13.5	.000	29.093		%641
	128	5.00	.00	20.4	.00	25.8	.40	13.3	.000	0.000		%647
	129	5.00	.00	20.6	2.60	22.7	.20	13.3	.000	44.667		%652
A	130	5.00	.00	21.5	2.20	23.0	.00	13.5	.000	41.120		%657
	131	5.00	.00	20.3	2.40	22.9	.60	13.3	.000	80.800		%663
	132	5.00	.00	22.2	.00	25.0	.00	13.6	.000	8.920		%668
	133	5.00	.00	20.5	2.60	22.7	.80	13.2	.000	69.600		%674
	134	5.00	.00	21.5	.20	24.8	.00	14.0	.000	32.587		%679
	135	5.00	.00	20.9	1.40	23.7	.40	13.3	.000	27.120		%684
	136	5.00	.00	22.3	3.00	22.5	.00	13.6	.000	32.419		%690
	137	5.00	.00	21.5	.00	26.0	.00	14.1	.000	20.533		%695
	138	5.00	.60	19.7	.00	25.4	.00	13.4	.000	91.467		%701
	139	5.00	.00	21.6	.00	26.2	.00	14.5	.000	43.650		%706
A	140	5.00	.00	23.2	.00	26.2	.00	14.6	.000	31.857		%711

A	141	5.00	.00	22.6	.00	26.2	.00	14.3	.000	33.833		%717
	142	5.00	.00	22.3	.00	26.2	.00	14.2	.000	27.467		%722
	143	5.00	.00	21.3	.00	28.0	.00	14.8	.000	44.615		%728
	144	5.00	.00	24.4	1.40	23.7	.00	14.3	.000	25.577		%733
	145	5.00	.00	21.4	.00	25.0	.00	13.8	.000	38.800		%738
	146	5.00	.00	22.0	1.00	24.0	.00	13.9	.000	37.600		%744
	147	5.00	.00	22.0	1.20	23.9	.00	13.7	.000	32.463		%749
	148	5.00	.00	23.7	.00	25.2	.00	15.1	.000	29.806		%755
	149	5.00	.00	22.5	2.20	23.0	.00	13.6	.000	23.745		%760
A	150	5.00	.00	21.3	.00	25.0	.00	13.8	.000	28.369		%765
	151	5.00	.00	21.4	3.00	22.5	.00	13.3	.000	0.000		%771
	152	5.00	.00	22.5	.40	24.6	.00	14.0	.000	17.636		%776
	153	5.00	.00	20.8	1.40	23.7	.20	13.3	.000	18.400		%782
	154	5.00	.00	20.0	.00	26.0	1.20	13.2	.000	0.000		%787
	155	5.00	.00	21.0	.00	26.9	.00	13.5	.000	22.618		%792

	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	%MIN
	156	5.00	.20	19.9	1.60	23.5	1.60	13.1	.000	336.80		%798
	157	5.00	.00	22.5	1.00	24.0	.00	13.8	.000	20.070		%803
	158	5.00	.00	20.7	3.00	22.5	1.80	13.1	.000	46.700		%808
	159	5.00	.00	20.5	2.20	23.0	.80	13.2	.000	79.200		%814
A	160	5.00	.00	21.2	1.80	23.4	.00	13.4	.000	9.133		%819
	161	5.00	1.00	19.5	3.00	22.5	5.40	12.6	.000	23.840		%825
	162	5.00	.00	21.9	.20	24.8	.00	13.6	.000	15.600		%830
	163	5.00	.00	21.3	1.40	23.7	.00	13.4	.000	42.154		%835
	164	5.00	.00	21.3	1.20	23.9	.00	13.4	.000	43.138		%841
	165	5.00	2.20	18.9	.00	26.0	1.00	13.2	.000	2.467		%846
A	166	5.00	.00	21.5	.60	24.4	.00	13.7	.000	10.93		%852

PROGRAM #= 3 [redacted] /11/85 07:50

REGION A: LL-UL= 0- 19 LCR= 0 BKG= .00 % 2 SIGMA= .0

REGION B: LL-UL= 19- 156 LCR= 0 BKG= .00 % 2 SIGMA= .0

REGION C: LL-UL= 0-2000 LCR= 0 BKG= .00 % 2 SIGMA= .0

TIME= 5.00 K= 1.000 WIP=SIS

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	MIN
3	1 Blank	10.00	28.50	11.8	13.90	16.9	55.70	8.47	.000	18.952	B	10
3	~~131~~ B1	5.00	.00	17.3	.00	27.4	.00	12.5	.000	45.638		684
3	132	5.00	.00	21.8	.00	24.6	.00	13.8	.000	22.874		690
3	133	5.00	1.90	16.2	.00	24.0	.00	12.1	.000	0.000		695
3	134	5.00	.00	18.2	.30	23.7	.00	12.6	.000	35.755		700
3	135	5.00	9.30	14.5	.00	27.2	5.90	11.4	.000	2.602		706
3	136	5.00	.00	18.1	1.70	22.6	.00	12.5	.000	21.345		711
3	137	5.00	.00	19.2	.00	29.8	.00	13.7	.000	14.187		716
3	138	5.00	.00	18.2	.00	24.8	.00	12.8	.000	32.947		722
3	139	5.00	.00	18.3	.00	25.4	.00	13.0	.000	22.118		727
3	~~140~~ B10	5.00	.00	19.8	.00	25.4	.00	13.4	.000	25.251		733
3	B 11	5.00	.00	18.4	1.00	25.2	.00	13.1	.000	55.029		16
3	B 12	5.00	.00	17.8	1.00	25.2	.00	13.0	.000	145.80		21
3	B 13	5.00	.00	18.9	1.00	25.2	.00	13.2	.000	26.440		27
3	B 14	5.00	2.20	16.8	4.00	22.6	3.40	12.2	.000	0.000		32
3	B 15	5.00	.00	18.3	2.60	23.7	.20	12.6	.000	37.800		37
3	B 16	5.00	3.80	16.3	1.00	25.2	3.20	12.2	.000	0.000		43
3	B 17	5.00	4.30	15.6	.00	24.6	2.30	11.7	.000	8.569		16
3	B 18	5.00	2.90	15.9	1.90	22.5	5.90	11.4	.000	22.124		21
3	19	5.00	.00	17.4	.00	25.4	.00	12.7	.000	18.112		27
3	20	5.00	.00	19.2	.00	24.0	.00	13.9	.000	18.496		32
3	21	5.00	3.10	15.9	.50	23.5	1.50	11.8	.000	11.006		38
3	22	5.00	.00	17.5	.00	26.0	.00	12.8	.000	36.207		43
3	23	5.00	.00	17.1	.00	25.0	.00	12.5	.000	8.427		48
3	24	5.00	.00	17.5	.10	23.9	.00	12.6	.000	37.037		54
3	25	5.00	.00	16.9	.00	28.5	.00	12.9	.000	78.857		59
3	26	5.00	4.70	15.5	.00	24.0	2.50	11.7	.000	22.759		64
3	27	5.00	.00	18.1	.00	25.8	.00	13.0	.000	33.884		70
3	28	5.00	.00	17.8	.00	26.7	.00	13.0	.000	33.600		75
3	29	5.00	1.10	16.4	.00	26.4	.00	12.4	.000	0.000		80
3	B 30	5.00	.00	18.1	.00	26.7	.00	13.2	.000	19.643		86
3	31	5.00	.00	17.2	.00	26.7	.00	12.7	.000	0.000		91
3	32	5.00	.00	17.6	.50	23.5	.00	12.8	.000	25.445		97
3	33	5.00	7.30	14.9	.00	25.2	5.30	11.4	.000	17.932		102
3	34	5.00	.00	17.4	.00	26.4	.00	12.7	.000	36.032		107
3	35	5.00	.00	16.9	.10	23.9	.00	12.2	.000	37.714		113
3	36	5.00	.00	16.9	.00	25.2	.00	12.3	.000	99.378		118
3	37	5.00	.00	18.3	1.10	23.0	.00	12.5	.000	15.843		123
3	38	5.00	2.50	16.0	.10	23.9	3.50	11.6	.000	32.192		129
3	39	5.00	755.70	3.19	.00	26.9	753.70	3.14	.000	11.181		134
3	B 40	5.00	.00	18.0	.00	26.4	.00	12.6	.000	20.130		140
3	41	5.00	.00	17.0	.00	26.7	.00	12.5	.000	39.418		145
3	42	5.00	.00	17.0	1.10	23.0	.00	12.1	.000	47.631		150
3	43	5.00	.00	17.0	.00	25.4	.00	12.7	.000	33.846		156
3	44	5.00	.00	17.1	.00	24.6	.00	12.8	.000	80.320		161
3	45	5.00	.10	16.7	.00	25.6	.00	12.4	.000	0.000		166
3	46	5.00	.00	16.9	.00	29.8	.00	12.7	.000	0.000		172
3	47	5.00	.00	18.0	.00	25.4	.00	12.9	.000	32.707		177
3	48	5.00	.00	16.8	.00	25.2	.00	12.4	.000	0.000		183
3	49	5.00	.00	17.8	.00	24.4	.00	12.7	.000	30.892		188
3	B 50	5.00	.00	16.8	.00	25.2	.00	12.4	.000	61.120		193

CONTROL NO. 80385

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	MIN
3	B 51	5.00	.00	17.9	.00	25.0	.00	12.6	.000	12.059		199
3	52	5.00	65.90	9.21	.00	27.2	65.10	8.14	.000	6.307		204
3	53	5.00	.00	17.5	.00	26.0	.00	12.7	.000	32.059		209
3	54	5.00	.00	17.2	.00	25.6	.00	12.7	.000	13.459		215
3	55	5.00	.00	20.1	.00	26.2	.00	13.9	.000	24.138		220
3	56	5.00	.00	17.9	.00	27.4	.00	13.2	.000	8.312		226
3	57	5.00	.00	16.9	.50	23.5	.90	11.8	.000	0.000		237
3	58	5.00	.00	17.6	.00	26.2	.00	12.9	.000	26.759		242
3	59	5.00	.30	16.6	.00	24.6	.00	12.0	.000	93.333		247
3	B 60	5.00	.00	17.1	.00	24.4	.00	12.6	.000	44.053		253
3	61	5.00	.00	18.3	.00	26.7	.00	12.9	.000	17.600		258
3	62	5.00	.00	18.1	.00	25.2	.00	13.1	.000	25.702		264
3	63	5.00	.00	17.6	.00	25.2	.00	12.8	.000	17.048		269
3	64	5.00	.00	18.7	.00	25.8	.00	13.4	.000	20.013		274
3	65	5.00	.00	18.3	.10	23.9	.00	12.8	.000	21.427		280
3	66	5.00	.00	19.0	.00	25.2	.00	13.0	.000	24.180		285
3	67	5.00	.00	18.7	.00	24.6	.00	13.0	.000	11.200		290
3	68	5.00	.00	18.1	.00	29.4	.00	13.1	.000	20.302		296
3	69	5.00	.00	18.1	.00	25.2	.00	12.9	.000	13.651		301
3	B 70	5.00	.00	17.5	.00	25.2	.00	12.6	.000	46.400		306
3	71	5.00	.00	17.8	.00	25.4	.00	12.9	.000	0.000		312
3	72	5.00	.00	17.0	.00	27.2	.00	12.4	.000	2.585		317
3	73	5.00	8.70	14.6	.00	26.9	7.10	11.2	.000	16.018		323
3	74	5.00	.00	17.8	.00	25.0	.00	12.8	.000	22.097		328
3	75	5.00	.00	17.1	.00	24.2	.00	12.2	.000	60.053		333
3	76	5.00	.00	17.9	.00	28.5	.00	13.3	.000	20.176		339
3	77	5.00	.00	18.4	.00	24.6	.00	12.9	.000	9.328		344
3	78	5.00	.00	17.2	.00	26.0	.00	12.9	.000	0.000		349
3	79	5.00	.00	17.8	.00	24.8	.00	12.6	.000	16.649		355
3	B 80	5.00	.00	17.2	.00	24.0	.00	12.4	.000	41.179		360
3	81	5.00	.00	17.8	.00	24.8	.00	12.9	.000	24.432		366
3	82	5.00	.00	17.8	.00	26.2	.00	13.0	.000	20.526		371
3	83	5.00	.00	19.0	.00	24.2	.00	12.6	.000	30.261		376
3	84	5.00	.00	17.5	.00	24.4	.00	12.5	.000	3.141		382
3	85	5.00	.00	18.0	.00	28.0	.00	13.2	.000	7.628		387
3	86	5.00	.00	17.7	.00	26.9	.00	12.9	.000	9.067		392
3	87	5.00	.00	18.9	.00	24.2	.00	13.1	.000	16.222		398
3	88	5.00	.00	16.9	.00	24.0	.00	12.0	.000	13.333		403
3	89	5.00	.00	17.3	.70	23.4	.00	12.4	.000	50.362		408
3	B 90	5.00	.00	17.3	.00	24.8	.00	12.6	.000	7.390		414
3	91	5.00	.00	19.0	.00	26.4	.00	13.3	.000	13.183		419
3	92	5.00	.00	17.8	.00	24.2	.00	12.5	.000	8.914		425
3	93	5.00	.00	17.8	1.90	22.5	.00	12.2	.000	34.789		430
3	94	5.00	.00	17.9	.50	23.5	.00	12.8	.000	29.463		435
3	95	5.00	.50	16.6	.10	23.9	.00	12.1	.000	0.000		441
3	96	5.00	.00	17.0	.00	26.2	.00	12.3	.000	68.308		446
3	97	5.00	.00	17.6	.10	23.9	.00	12.7	.000	15.614		451
3	98	5.00	.00	16.9	.00	26.0	.00	12.8	.000	0.000		457
3	99	5.00	.00	17.2	.30	23.7	.00	12.1	.000	0.000		462
3	B 100	5.00	.00	17.4	.00	24.2	.00	12.2	.000	17.739		468

3 B	101	5.00	.00	17.8	.00	25.2	.00	12.8	.000	18.971		473
3	102	5.00	.00	17.6	.00	24.2	.00	12.4	.000	28.439		478
3	103	5.00	.00	18.7	.30	23.7	.00	13.0	.000	20.538		484
3	104	5.00	.00	19.0	.00	24.2	.00	12.8	.000	24.788		489
3	105	5.00	.00	19.5	.00	24.2	.00	13.3	.000	22.815		494
3	106	5.00	.00	17.9	.00	26.9	.00	13.1	.000	15.961		500
3	107	5.00	.00	17.7	.30	23.7	.00	12.7	.000	21.867		505
3	108	5.00	.00	17.0	.90	23.2	.00	12.3	.000	0.000		511
3	109	5.00	.00	18.3	.00	25.0	.00	12.9	.000	14.400		516
3 B	110	5.00	5.70	15.2	.00	26.0	1.10	11.8	.000	14.834		521
3	111	5.00	.00	20.2	2.10	22.3	.00	13.1	.000	20.564		527

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	MIN
3	112	5.00	.00	18.9	.00	27.4	.00	13.0	.000	17.218		532
3	113	5.00	.00	17.7	.00	25.4	.00	12.6	.000	31.564		537
3	114	5.00	.70	16.5	.00	24.8	.00	12.2	.000	33.143		543
3	115	5.00	.00	17.8	.00	24.6	.00	12.6	.000	29.622		548
3	116	5.00	.00	17.4	.00	25.6	.00	12.6	.000	0.000		554
3	117	5.00	.00	16.9	.00	26.2	.00	12.5	.000	76.978		609
3	118	5.00	.00	17.0	.00	27.4	.00	12.5	.000	10.618		614
3	119	5.00	.00	19.5	.00	24.2	.00	13.1	.000	11.595		620
3	120	5.00	.00	18.1	.00	24.0	.00	12.8	.000	23.218		625
3	121	5.00	3.30	15.8	.10	23.9	4.30	11.5	.000	0.000		631
3	122	5.00	.10	16.7	.00	25.2	.00	12.1	.000	0.000		636
3	123	5.00	1.30	16.3	.50	23.5	3.10	11.6	.000	62.892		641
3	124	5.00	.00	17.4	.00	25.6	.00	12.7	.000	10.226		647
3	125	5.00	4.90	15.4	.00	24.6	4.90	11.4	.000	11.263		652
3	126	5.00	.00	17.8	.00	28.0	.00	12.6	.000	20.022		657
3	127	5.00	.00	17.4	.00	24.0	.00	12.4	.000	15.296		663
3	128	5.00	2.10	16.1	.00	24.4	.00	12.0	.000	10.133		668
3	129	5.00	.00	16.9	.00	25.2	.00	12.4	.000	29.029		673
3	130	5.00	7.10	14.9	.00	27.2	.00	12.0	.000	9.664		679

REGION A: LL-UL= 0- 19 LCR= 0 BKG= 0 % 2 SIGMA= .2
REGION B: LL-UL= 19- 156 LCR= 0 BKG= 0 % 2 SIGMA= .2
REGION C: LL-UL= 0-2000 LCR= 0 BKG= 0 % 2 SIGMA= .2
TIME= 5.00 QIP= SIS SCR= B/A K= 1.000

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	QIP	FLAGS	SCR	MIN
6	blanks 1	10.00	31.30	11.3	13.50	17.2	57.00	3.32	SIS.	3	.471	11
6 B	131	5.00	.00	16.5	.00	25.2	.00	12.3	428.	?	.000	16
6	22	5.00	.00	17.3	.70	23.7	.00	12.3	481.	?	.000	22
6	23	5.00	.00	16.3	2.30	22.5	.00	11.3	538.	?	.200	27
6	24	5.00	1.90	15.5	.90	23.5	4.40	11.3	491.	?	.470	32
6	25	5.00	.70	15.3	.10	24.2	3.20	11.4	567.	?	.143	38
6	26	5.00	.70	15.3	.00	26.2	.40	11.7	620.	?	.000	43
6	27	5.00	.00	16.6	3.50	21.6	1.00	11.3	536.	?	.000	48
6	28	5.00	.00	16.5	2.50	22.3	2.60	11.5	602.	?	.000	54
6	29	5.00	.00	16.2	2.50	22.3	.60	11.7	520.	?	.000	59
6	140	5.00	.00	18.1	2.50	22.3	.00	12.3	520.	?	.000	64

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	DIP	FLAGS	SCR	MIN
6	B141	5.00	.00	17.6	1.90	22.7	.00	11.3	[illegible]	?	.000	70
6	32	5.00	.00	16.7	1.70	22.3	1.20	11.5	597.	?	.000	75
6	33	5.00	7.30	14.4	2.30	22.0	11.60	10.7	459.		.397	80
6	34	5.00	.00	17.9	.00	25.2	.00	12.3	566.	?	.000	85
6	35	5.00	7.30	14.2	.00	25.3	5.00	11.2	706.		.300	91
6	36	5.00	.00	16.7	1.50	23.0	1.00	11.6	556.	?	.000	96
6	37	5.00	.70	15.8	.00	24.4	7.40	11.4	632.		.000	101
6	38	5.00	7.10	14.4	.00	25.3	6.40	11.1	450.		.000	107
6	39	5.00	.00	16.5	.00	25.0	.00	11.3	538.	?	.000	112
6	B150	5.00	.00	16.5	.00	24.4	.00	11.3	490.	?	.000	117
6	41	5.00	.00	17.3	.00	26.7	.00	12.6	548.	?	.000	123
6	42	5.00	.00	17.3	.00	24.3	.00	12.7	520.	?	.000	128
6	43	5.00	.00	16.7	2.30	22.5	1.00	11.3	465.	?	.000	133
6	44	5.00	.00	17.6	.90	23.5	.00	12.2	531.	?	.000	139
6	45	5.00	.00	16.7	.10	24.2	.00	12.3	452.	?	.000	144
6	46	5.00	.00	16.3	1.50	23.0	.00	11.7	536.	?	.000	149
6	47	5.00	.10	15.9	.00	25.0	.00	11.8	437.		.000	154
6	48	5.00	.00	16.3	.00	24.3	.00	12.7	549.	?	.000	160
6	49	5.00	3.70	15.1	.30	24.3	4.00	11.3	456.		.001	165
6	B160	5.00	.00	16.7	.30	24.9	.00	11.9	530.	?	.000	170
6	161	5.00	.00	16.3	.00	24.6	.00	11.7	465.	?	.000	176
6	162	5.00	3.30	15.2	.00	24.8	5.80	11.2	551.		.000	181
6	163	5.00	.00	16.6	1.30	23.2	1.20	11.6	605.	?	.000	186
6	164	5.00	.00	16.8	.00	25.6	.00	12.1	553.	?	.000	192
6	165	5.00	.00	17.2	.10	24.2	.00	12.3	527.	?	.000	197
6	56	5.00	4.30	14.9	.00	25.0	6.60	11.3	506.		.000	202
6	57	5.00	.00	16.4	.90	23.5	.40	11.7	552.	?	.000	208
6	58	5.00	.00	16.9	1.70	22.3	.00	12.0	494.	?	.000	213
6	59	5.00	.00	17.2	.00	25.6	.00	12.3	509.	?	.000	218
6	B170	5.00	.00	16.7	.50	23.9	.00	11.9	589.	?	.000	223
6	61	5.00	.00	18.1	.50	23.9	.00	12.2	679.	?	.000	229
6	62	5.00	.00	18.1	.00	25.2	.00	12.3	631.	?	.000	234
6	63	5.00	.00	18.1	1.50	23.0	.00	12.3	610.	?	.000	239
6	64	5.00	.00	16.1	1.90	22.7	3.00	11.4	518.	?	.000	245
6	65	5.00	.00	17.4	.70	23.7	.00	12.3	697.	?	.001	250
6	66	5.00	.00	16.3	2.10	22.6	.00	11.3	96.		.001	255
6	67	5.00	.00	16.5	3.10	21.9	12.60	11.4	538.	?	.000	261
6	68	5.00	.90	15.7	2.10	22.6	2.20	11.5	441.		.001	266
6	69	5.00	.00	17.3	.50	23.9	.00	12.4	624.	?	.000	271
6	B180	5.00	.00	16.4	.00	24.6	.00	11.7	619.	?	.000	277
6	71	5.00	.00	18.1	.30	24.3	.00	12.4	530.	?	.000	282
6	72	5.00	.00	18.4	.90	23.5	.00	12.7	549.	?	.000	287
6	73	5.00	.00	16.3	3.30	21.9	.00	11.9	448.	?	.000	293
6	74	5.00	.00	16.7	3.10	21.9	.20	11.7	525.	?	.000	298
6	75	5.00	.00	16.8	.00	25.4	.00	12.1	508.	?	.000	303
6	76	5.00	.00	16.3	.70	23.7	.00	11.9	439.	?	.000	309
6	77	5.00	.00	17.2	.00	25.6	.00	12.2	646.	?	.000	314
6	78	5.00	.00	16.7	.00	25.2	.00	12.1	542.	?	.000	319
6	79	5.00	.50	15.9	1.70	22.3	1.40	11.3	433.		.100	324
6	B190	5.00	.00	17.0	2.30	22.1	2.60	11.3	641.	?	.000	330

6	181	5.00	.00	17.6	.00	25.0	.00	12.5	538.	?	.000	335
6	82	5.00	.00	18.1	1.30	23.3	.00	12.4	624.	?	.000	341
6	83	5.00	.00	16.5	.50	23.9	.00	11.9	559.	?	.000	346
6	84	5.00	.00	16.9	1.70	23.2	.00	12.3	505.	?	.000	351
6	85	5.00	.00	16.0	4.90	20.3	5.20	11.3	532.	?	.000	356
6	86	5.00	.00	17.1	1.50	23.0	.00	11.7	613.	?	.000	362
6	87	5.00	.00	16.9	1.30	23.2	.00	11.8	592.	?	.000	367
6	88	5.00	.00	17.7	1.50	23.0	.00	12.4	538.	?	.000	372
6	89	5.00	.00	17.2	4.50	21.3	3.40	11.4	630.	?	.000	378
6	190	5.00	.00	17.5	.00	25.3	.00	12.3	538.	?	.000	383
6	91	5.00	1.10	15.7	.50	23.9	.60	11.7	428.		.455	388
6	92	5.00	.00	16.7	.00	25.6	.00	12.1	579.	?	.000	394
6	93	5.00	.00	17.1	.00	25.4	.00	12.4	530.	?	.000	399
6	94	5.00	.00	16.5	.00	24.8	.00	11.9	548.	?	.000	404
6	95	5.00	.00	17.6	1.30	23.2	.00	12.2	560.	?	.000	410
6	96	5.00	.00	16.7	.00	24.6	.00	12.2	541.	?	.000	415
6	197	5.00	.00	17.3	1.10	23.4	.00	12.1	518.	?	.000	420
6	198	5.00	.00	16.2	1.10	23.4	.00	11.7	448.	?	.000	425
6	199	5.00	.00	17.6	1.10	23.4	.00	11.8	661.	?	.000	431
6	B21	5.00	.00	16.3	.50	23.9	.00	11.8	459.	?	.000	436
6	101	5.00	1.30	15.6	1.50	23.0	3.40	11.4	492.		1.154	441
6	102	5.00	8.30	14.2	4.10	21.5	12.40	10.5	531.		.494	447
6	103	5.00	.00	16.3	2.10	22.5	1.80	11.5	466.	?	.000	452
6	104	5.00	.00	17.5	.70	23.7	.00	12.4	460.	?	.000	457
6	105	5.00	.00	17.2	.70	23.7	.00	12.2	466.	?	.000	463
6	106	5.00	.00	16.7	3.10	21.9	1.20	11.6	532.	?	.000	468
6	107	5.00	22.10	12.2	.30	24.0	22.00	10.0	745.		.014	473
6	108	5.00	.00	16.1	.00	25.2	.00	12.1	441.	?	.000	479
6	109	5.00	1.90	15.5	.00	26.4	.20	11.7	544.		.000	484
6	110	5.00	.00	18.1	.00	25.6	.00	12.5	652.	?	.000	489
6	221	5.00	.00	18.6	.00	24.4	.00	12.0	679.	?	.000	495
6	112	5.00	.00	16.1	5.90	20.3	2.20	11.0	597.	?	.000	500
6	113	5.00	.10	15.3	.70	23.7	2.60	11.5	567.		1.000	505
6	114	5.00	.00	16.5	.90	23.5	.40	11.7	553.	?	.000	510
6	115	5.00	.00	16.3	.10	24.3	.00	12.0	572.	?	.000	516
6	116	5.00	.00	16.1	.00	25.2	.00	11.9	547.	?	.000	521

F#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	DIF	FLAGS	SCR	MIN
6	B227	5.00	.00	16.9	2.90	22.3	1.40	11.5	578.	?	.000	526
6	228	5.00	.00	16.6	2.50	22.5	1.60	11.6	597.	?	.000	532
6	B229	5.00	.00	16.6	.30	24.3	.00	11.7	545.	?	.000	537

CONTROL NO. 80385

PROGRAM #=. 3 03/12/85 05:34
REGION A: LL-UL= 0- 19 LCR= 0 BKG= .00 % 2 SIGMA= .0
REGION B: LL-UL= 19- 156 LCR= 0 BKG= .00 % 2 SIGMA= .0
REGION C: LL-UL= 0-2000 LCR= 0 BKG= .00 % 2 SIGMA= .0
TIME= 5.00 K= 1.000 QIP=SIS

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	MIN
3	blanks	10.00	28.30	11.8	12.80	17.6	54.00	8.61	.000	20.593	B	10
3	C1	5.00	3.30	15.9	.40	24.6	5.40	11.6	.000	0.000		16
3	C2	5.00	.00	17.5	.00	28.2	.00	13.2	.000	50.432		21
3	C3	5.00	.00	18.0	2.20	23.0	.00	12.5	.000	15.376		26
3	C4	5.00	1.50	16.3	1.80	23.4	4.40	11.7	.000	0.000		32
3	C5	5.00	56.30	9.72	8.80	19.2	60.40	8.36	.000	26.095		37
3	C6	5.00	50.50	10.0	.00	25.2	44.60	9.01	.000	13.091		43
3	C7	5.00	74.70	8.81	18.00	16.1	92.40	7.39	.000	25.094		48
3	C8	5.00	25.70	12.1	2.60	22.7	25.80	10.0	.000	13.086		53
3	C9	5.00	.00	17.6	.00	25.6	.00	12.7	.000	46.222		59
3	C10	5.00	.00	16.8	.80	24.2	.00	12.2	.000	608.00		64
3	C13	5.00	2.30	10.6	.80	24.2	42.60	9.10	.000	7.952		69
3	C14	5.00	8.10	14.8	1.60	23.5	7.20	11.4	.000	0.000		75
3	C15	5.00	1.30	16.4	.00	25.2	1.00	12.0	.000	0.000		80
3	C16	5.00	.00	18.6	.00	26.4	.00	13.1	.000	27.846		85
3	C17	5.00	.00	18.3	1.80	23.4	.00	12.5	.000	25.274		91
3	D1	5.00	210.90	5.78	.00	27.2	206.40	5.54	.000	9.731		96
3	D2	5.00	3.90	15.7	.00	26.2	.00	12.4	.000	15.220		102
3	D3	5.00	.00	18.8	.00	25.8	.00	13.3	.000	31.633		107
3	D4	5.00	.00	19.7	.40	24.6	.00	13.7	.000	25.523		112
3	D5	5.00	.00	18.5	.80	24.2	.00	13.1	.000	43.113		118
3	D6	5.00	.00	19.5	.80	24.2	.00	13.6	.000	25.316		123

CONTROL NO. 80385

ATTACHMENT C

LSC MODEL 4530

```
PROGRAM #=     7
REGION A:     LL-UL=     0-  19  LCR=     0  BKG=     .00  % 2 SIGMA=     .0
REGION B:     LL-UL=    19- 156  LCR=     0  BKG=     .00  % 2 SIGMA=     .0
REGION C:     LL-UL=     0-2000  LCR=     0  BKG=     .00  % 2 SIGMA=     .0
TIME=   5.00  K= 1.000 QIP=SIS                                01/01/00  05:29
LUMINESCENCE CORRECTION OFF
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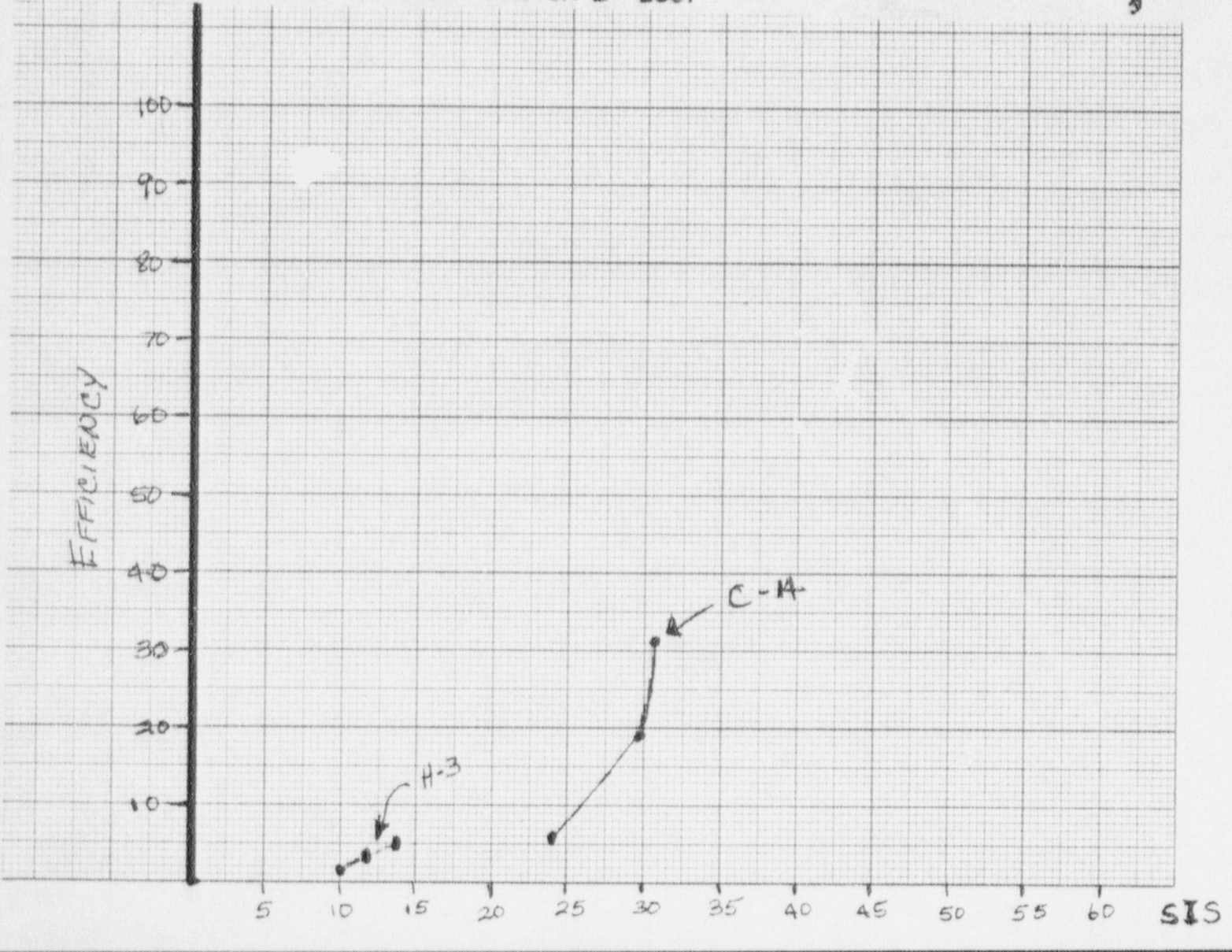
P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	%MIN
7	1	5.00	55757.4	.38	31011.0	.51	86784.4	.30	.000	30.537	1	5
7	2	5.00	52870.6	.39	19029.6	.65	71915.9	.33	.000	29.786	1	11
7	3	5.00	50567.4	.40	6474.00	1.11	57054.2	.37	.000	24.159	1	17
7	5	5.00	4444.20	1.34	15.40	22.7	4471.20	1.34	.000	13.655		22
7	6	5.00	3215.80	1.58	14.20	23.7	3243.40	1.57	.000	11.607		27
7	7	5.00	1373.80	2.41	15.60	22.6	1404.20	2.39	.000	9.580		33

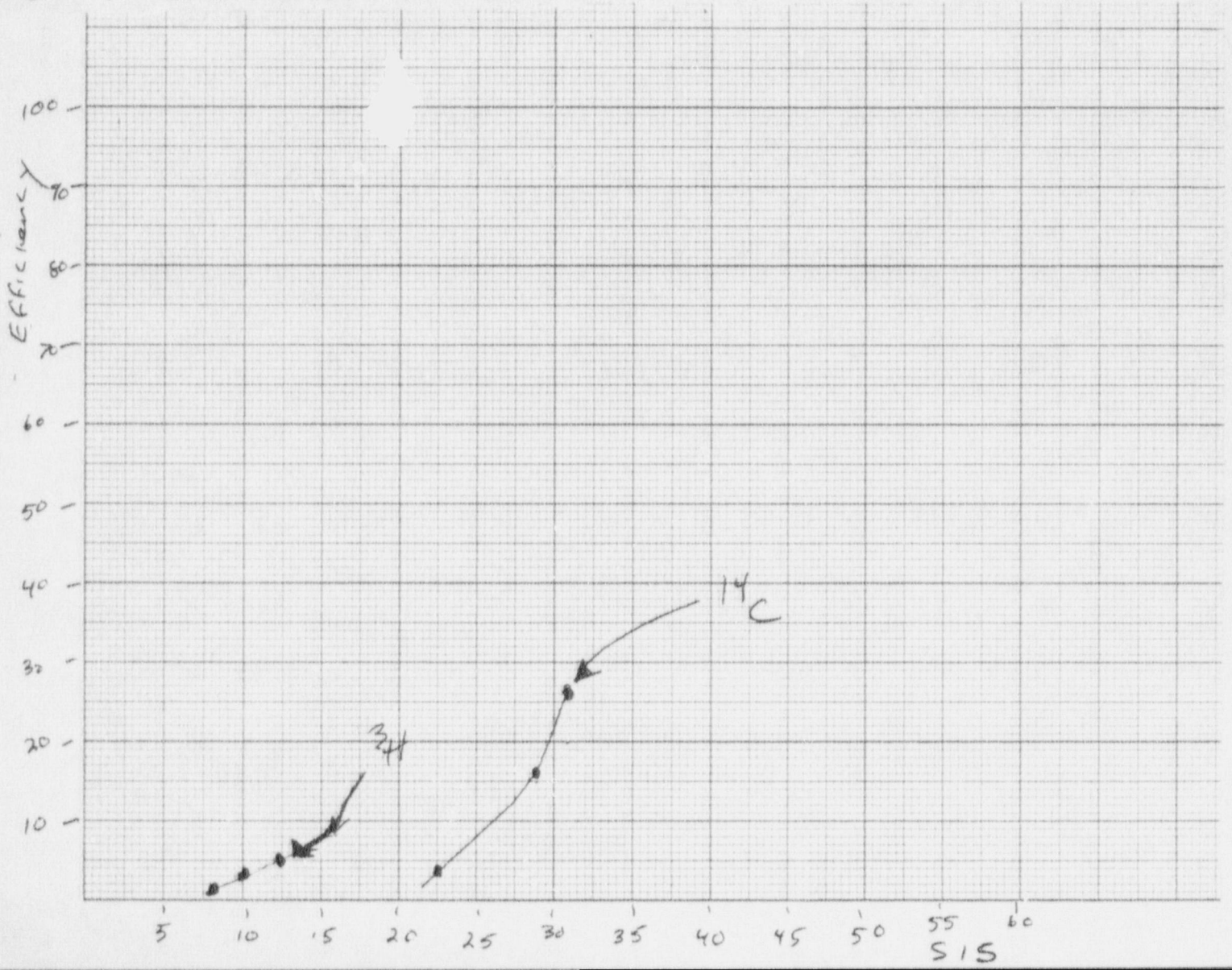
NORMALIZATION FACTOR 1= 1902 FACTOR 2= 2337



LSC MODEL 4640

PROGRAM #= 3 03/12/85 10:24
REGION A: LL-UL= 0- 19 LCR= 0 BKG= .00 % 2 SIGMA= .0
REGION B: LL-UL= 19- 156 LCR= 0 BKG= .00 % 2 SIGMA= .0
REGION C: LL-UL= 0-2000 LCR= 0 BKG= .00 % 2 SIGMA= .0
TIME= 5.00 K= 1.000 QIP=SIS

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	MIN
3	1	5.00	62818.1	.36	26003.2	.55	88839.0	.30	.000	30.334		6
3	2	5.00	58747.6	.37	16728.2	.69	75490.4	.33	.000	29.706		12
3	3	5.00	57935.0	.37	4430.20	1.34	62376.8	.36	.000	22.530		17
3	5	5.00	5282.80	1.23	14.00	23.9	5311.40	1.23	.000	12.284		22
3	6	5.00	3900.40	1.43	12.60	25.2	3924.20	1.43	.000	10.193		28
3	7	5.00	1917.20	2.04	12.60	25.2	1943.80	2.03	.000	8.257		33



ATTACHMENT D

PROGRAM #= 3 03/12/85 12:18

REGION A:	LL-UL= 0- 19	LCR= 0	BKG= .00	% 2 SIGMA= .0		
REGION B:	LL-UL= 19- 156	LCR= 0	BKG= .00	% 2 SIGMA= .0		
REGION C:	LL-UL= 0-2000	LCR= 0	BKG= .00	% 2 SIGMA= .0		

TIME= 5.00 K= 1.000 QIP=SIS

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	MIN
3	blank	10.00	26.00	12.4	11.60	18.5	49.80	8.96	.000	21.084	B	10
3	A-71	5.00	.00	18.4	3.40	23.0	1.60	12.4	.000	52.492		48
3	B-39	5.00	2.60	16.7	.20	26.0	3.60	12.2	.000	0.000		53
3	B-52	5.00	3.00	16.6	1.60	24.6	4.20	12.1	.000	0.000		59
3	D-1	5.00	114.60	7.54	.80	25.4	115.20	6.96	.000	10.641		64

recipes

P#	S#	TIME	CPMA/K	%DEV	CPMB/K	%DEV	CPMC/K	%DEV	SIE	SIS	FLAGS	MIN
3	blank	10.00	28.20	11.9	12.70	17.7	52.20	8.75	.000	17.456	B	10
3	D-1	5.00	31.40	11.5	.00	25.2	32.80	9.70	.000	17.683		16

2nd recipe

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U. S. Nuclear Regulatory Commission
Division of Fuel Cycle and Material Safety
Washington, D.C. 20555

July 1982

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of the survey report shall be filed with the Division of Fuel Cycle and Material Safety, USNRC, Washington, D.C. 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

   a. Identify the premises.

   b. Show that reasonable effort has been made to eliminate residual contamination.

   c. Describe the scope of the survey and general procedures followed.

   d. State the findings of the survey in units specified in the instruction.

   Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

TABLE 1

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[b c f]	MAXIMUM[b d f]	REMOVABLE[b e f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm^2	3000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1000 dpm $\beta\gamma$/100 cm^2

a. Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

b. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c. Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

d. The maximum contamination level applies to an area of not more than 100 cm^2.

e. The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

f. The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.